Agricultural dynamics and food security trends in Kenya

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Developmental Regimes in Africa (DRA) Project
ASC-AFCA Collaborative Research Group:
Agro-Food Clusters in Africa (AFCA)

Research Report 2013-ASC-4

London/Leiden, January 2014

Published on behalf of the Developmental Regimes in Africa Project by the Overseas Development Institute, 203 Blackfriars Road, London SE1 8NJ, UK (www.odi.org.uk).

The DRA project is funded by the Netherlands Ministry of Foreign Affairs. It builds on the work of the Africa Power and Politics Programme, which was supported by DFID and Irish Aid, and Tracking Development, which was funded by the Netherlands. The project is a partnership of the Overseas Development Institute, the African Studies Centre in Leiden and the University of Leiden. The views expressed in this publication are those of the authors and not necessarily those of any of the partner organisations or funding bodies.

These research reports are co-funded by the African Studies Centre in Leiden.

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General introduction to the four DRA/ASC-AFCA Research Reports

From 'Tracking Development' to 'Developmental Regimes in Africa' and 'Agro-Food Clusters in Africa': further research questions

Between 2007 and 2012 the Netherlands Ministry of Foreign Affairs funded a research project to compare the long-term developments in Southeast Asia and Sub-Saharan Africa. Long-term meant: with a focus on the second half of the 20th century. The main research question was: how could countries, which were all having low levels of socio-economic performance in the 1950s, differ so much in economic performance in the following decades? The research team consisted of researchers from the Royal Netherlands Institute of Southeast Asian and Caribbean Studies (KITLV) and the African Studies Centre, both in Leiden, together with senior and PhD researchers in four Southeast Asian and four African countries, which were compared one-to-one: Nigeria with Indonesia, Uganda with Cambodia, Kenya with Malaysia and Tanzania with Vietnam.[1] One of the main conclusions drawn by project leaders David Henley (KITLV) and Jan Kees van Donge (ASC) was that the economic breakthrough in Southeast Asia can only be well understood if one looks at the massive state-led rural development campaigns from the 1960s onwards, which resulted in a major agricultural revolution and in generally successful rural poverty alleviation on a mass scale. This was much less so in Africa, where many political leaders in post-colonial governments have made different choices, neglecting the rural peasants and trying to implement an elite-based industrialization strategy that had disappointing results (Henley & van Donge 2012; Vlasblom 2013).[2] The DfID-funded Africa Power and Politics Project (APPP) came to a comparable conclusion, focusing on Africa's ruling elites: these elites exploited or ignored the rural masses and can be held responsible for economic stagnation and rampant poverty and hunger. The important scientific and policy question can then be asked: if Africa would put more emphasis now on its agricultural sector (like Southeast Asia did from the 1960s onwards), would it be possible to repeat the 'growth miracle' and combine an agriculture-based rapid growth strategy, with a successful poverty alleviation strategy, particularly in the rural areas?

Although these main conclusions were shared by most participants in the Tracking Development team, there is quite some controversy about the causal factors, and about more recent

[1] Results of the Tracking Development project can be found in Berendsen, B., T. Dietz, H. Schulte Nordholt & R. van der Veen (2013), *Asian Tigers, African Lions. Comparing the Development Performance of Southeast Asia and Africa*. African Dynamics, Vol.12 Leiden: Brill. The chapter most relevant to this working paper series is Dietz T. (2013), Comparing the agricultural performance of Africa and Southeast Asia over the last fifty years: pp. 85-128, and for this working paper on Kenya: Fernando, J. (2013), Agricultural and rural development in Malaysia and Kenya and the politics of policy: pp. 229-256, as well as Nyanjom, O. (2013), The politics of policy for poverty reduction: comparing Malaysia with Kenya: pp. 257-288.

[2] Henley, D. & J.K. van Donge (2012), Policy for development in Africa: Learning from Southeast Asia. London Developmental Regimes in Africa Policy Brief 01; Vlasblom, D. (2013), *The richer harvest. Economic development in Africa and Southeast Asia compared*. Leiden: African Studies Centre.

trends. Based on statistical evidence from FAO sources (FAOSTAT), four DRA/ASC-AFCA Research Reports deal with these dynamics and with recent trends and show that a) not all was gloomy in Africa's agricultural performance between 1960 and 2000, and that b) from about 2000 onwards major breakthroughs can be seen, suggesting that Africa's agricultural sector *is* improving, or even that Africa is already experiencing an 'agricultural revolution', although a different one than Southeast Asia's "Green Revolution". The Research Reports focus on the four African case-study countries in the Tracking Development project: Nigeria, Uganda, Kenya and Tanzania. For each country four types of analysis are presented: (1) agricultural production trends in the 1960-2011 period, (2) food balance trends during this period, combining these agricultural food production data with data on trade and consumption, (3) high-growth agricultural products in the 2000-2010 period ('agricultural islands of effectiveness'), and (4) data on food security, based on child undernutrition surveys, and (if available) trends. The Research Reports also include some relevant maps made available by the Centre for World Food Studies in Amsterdam. For each country, the Research Report ends with suggestions for a follow-up research agenda and with a first inventory of useful sources, made by the ASC's library and documentation unit.

These four DRA/ASC-AFCA Research Reports are the first results of a Collaborative Research Group at the African Studies Centre in Leiden dealing with Agro-Food Clusters in Africa. Other studies will follow, both about these four countries and about other African countries. The research group intends to study four types of 'drivers of agricultural innovation breakthroughs and blockages': (i) urbanization and urban demand development for agricultural produce from relevant hinterlands; (ii) demand from elsewhere (for food, biofuels, and other export crops); (iii) business development and institutional arrangements in relevant value chains; and (iv) agricultural and rural development policies and practices. In the Tracking Development and APPP groups, the latter 'driver' received a lot of attention. In the ASC-AFCA team we tend to give due emphasis to the first driver of agricultural breakthroughs, which are currently happening all over Africa. We hope to be able to form research teams for particular agricultural products to do a detailed and, if possible, comparative (intra-African) analysis to determine the relative strengths of each of these four drivers of change for each of the 'agricultural islands of effectiveness' in the four countries and elsewhere in Africa.

One methodological remark should be made beforehand. Although FAO puts a lot of effort in its statistical data base, many researchers doubt the accuracy of these data. Some researchers even state that these data should not be used, and certainly not if one wants to compare countries. While acknowledging these caveats, in the Tracking Development project and in this DRA/ASC-AFCA follow-up research (as well as in the broader ASC-AFCA project) we are convinced that the FAOSTAT data collected over the past 50 years represent a unique statistical resource and deserves to be explored and exploited as a *starting point* and possible background canvas for any discussion about food security trends in the case study countries. However: it should be triangulated with other sources and treated with caution.

1. Introduction

Kenya is a country in East Africa with currently 47 Counties, including the capital city of Nairobi (see http://en.wikipedia.org/wiki/Counties_of_Kenya and Figure 1), relatively high population densities in the areas north of Nairobi, in Mombasa along the Coast and near Lake Victoria, and low densities in most of the arid and semi-arid areas (see Figure 2). Population densities and the history of British Colonial rule strongly determine the current population densities (see Figure 3 for Kenya's annual rainfall distribution and Figure 4 for the Colonial division of the 'White Highlands' and the 'Tribal Areas'). Kenya still has a relatively low urbanization rate, only 24% in 2011 according to the CIA Factbook[3], although other sources put the figure higher (up to almost 40%[4]). Major cities are Nairobi (according to the most recent Population Census of 2009: 3.1 million inhabitants), Mombasa at the Coast (0.9 m.), Nakuru and Eldoret in the Rift Valley (0.3 m.), Kisumu near Lake Victoria (0.3 m.), Ruiru (0.2 m., Kikuyu (0.2 m.), Mavoko/Athi River (0.1 m.), Ngong (0.1) and Karuri, all near Nairobi, and Garissa (0.1 m.) in the Somali part of Kenya.[5] Figure 5 gives an overview of Kenya's (peri-)urban population.

Figure 1: Kenya: administrative areas

Source: https://opendata.go.ke/stylesheets/images/domains/kenya.socrata.com/counties.gif

[3] https://www.cia.gov/library/publications/the-world-factbook/fields/2212.html
[4] http://www.the-star.co.ke/news/article-71472/urbanisation-continue-driving-housing-demand
[5] http://www.citypopulation.de/Kenya-Cities.html

Figure 2: Population densities

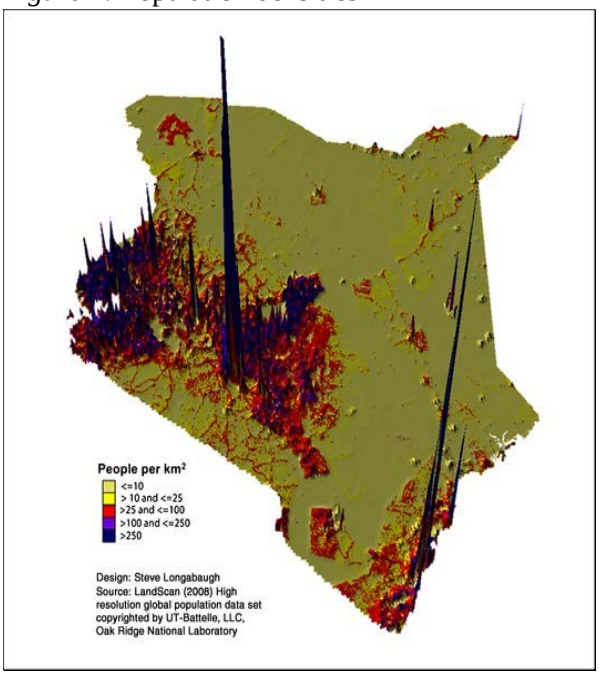
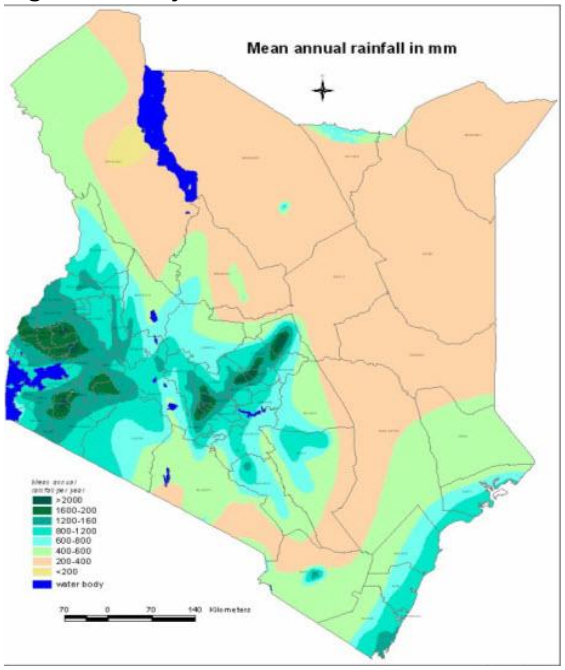


Figure 3: Kenya's annual rainfall



Source Figure 2:
http://www.springerimages.com/img/Images/Springer/JOU=12571/VOL=2012.4/ISU=3/ART=174/MediaObjects/MEDIUM_12571_2012_174_Fig1_HTML.jpg
Source Figure 3: : http://www.infonet-biovision.org/res/res/files/3147.800x700.jpeg

Figure 4: Kenya in Colonial times:
White Highlands and Tribal Areas

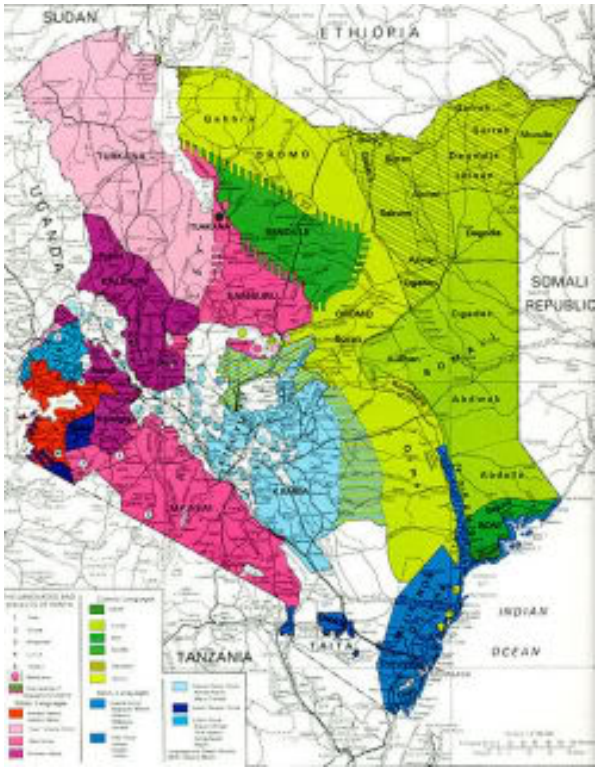
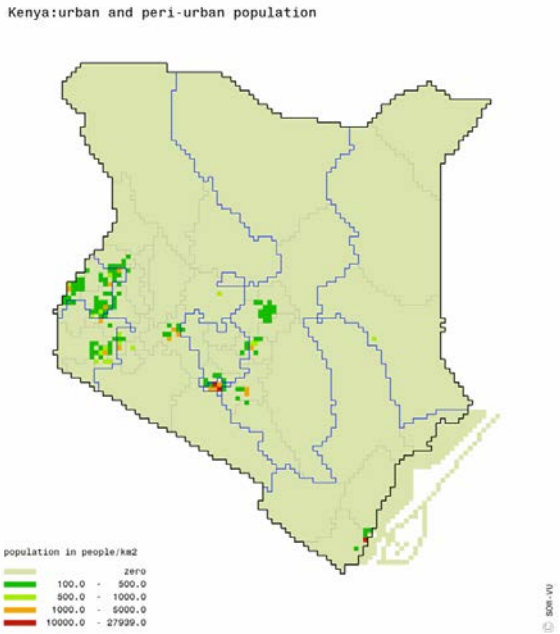


Figure 5: Urban and peri-urban areas in Kenya



Source Figure 4: http://i83.photobucket.com/albums/j313/unitarymoonbat/Kenya/466px-Kenya_Dialect_map.jpg
Source Figure 5: Van Wesenbeeck, C.F.A. & M.D. Merbis (2012), *Africa in Maps, data repository of the food economy in Sub-Saharan Africa*. Amsterdam: Centre for World Food Studies *('zero' = rural or water)*

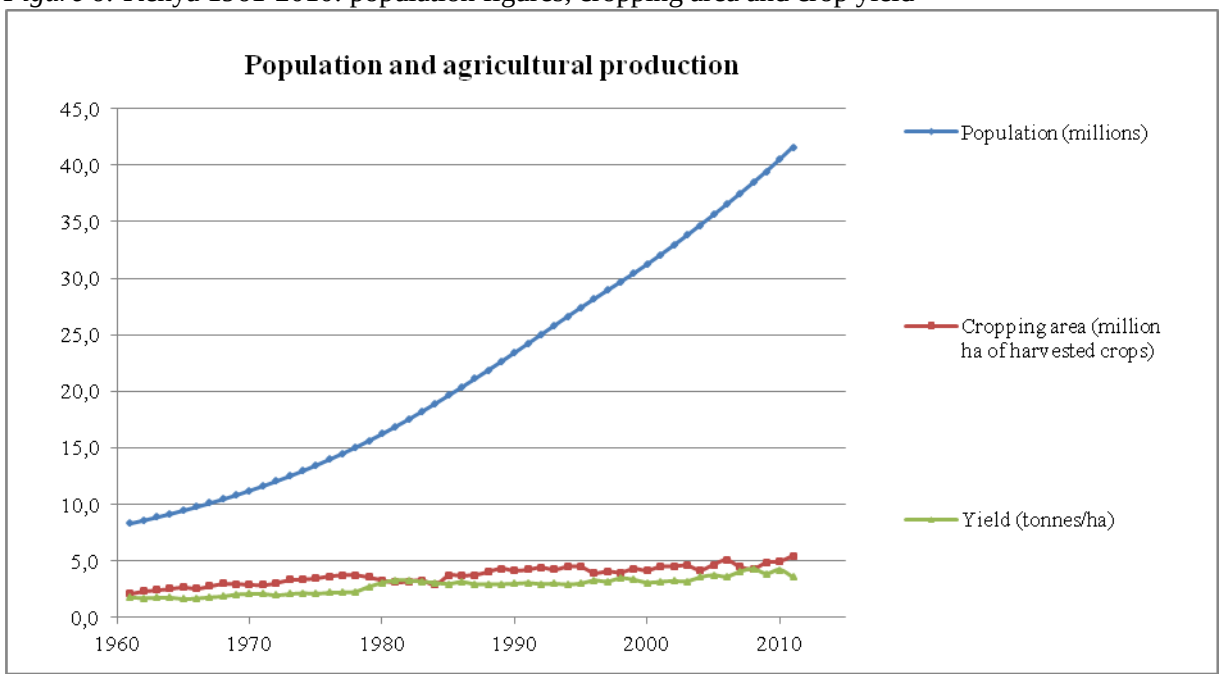
2 Kenya's agricultural dynamics, 1961-2011

Kenya has had an extremely high population growth over the last fifty years, experiencing an almost five-fold increase in its population. In 1961 it could feed its 8.4 million people at more than 10% above WHO requirements, assuming that basic foods contribute 75% of the dietary energy (see Annex 1). In the 1960s, basic food crop production improved both in terms of area harvested and in terms of (slight) yield and, as a result, its population reached a food-sufficiency level based on local production almost 20% higher than WHO requirements. After 1970, the situation began to deteriorate, partly as a result of diminishing government support for agriculture and rural development (Fernando, 2013: 237) and partly by deepening socio-economic divides (Nyanjom, 2013: 272). Crop production areas expanded somewhat in the 1970s but yields dropped, partly due to severe droughts. During the 1980s the harvested area of cereals, roots and tubers stabilized and that of pulses more than doubled, and yields recovered, for roots and tubers to their highest levels ever. In the 1990s yield levels deteriorated for all basic food crops and the harvested area of pulses declined again. The last decade started to show impressive improvements, until 2006: harvested areas for the most important basic food crops (mainly maize) reached an all-time high (2.4 m ha) while average cereal yield levels improved from 1370 kg/ha in 2000 to 1650 kg/ha in 2006. Kenya produced 3.9 million tons of cereals, 0.7 million tons of pulses and 3.8 million tons of roots and tubers in 2006. Its total basic food production could have potentially fed 96% of its population that year, up from 68% in 2000 (assuming that staple foods cover 65% of energy requirements). At the end of 2007, the political situation went disastrously wrong and many farmers had to seek refuge in camps or with relatives elsewhere and to abandon their fields. Statistics show that the harvested cereal area went down 15% (although average yields improved in those areas where cereals could be harvested, up to 1770 kg/ha). In 2008 there was a further reduction in the area under cultivation but yields fell back to only 1420 kg/ha and in 2009 they even hit average levels below those of 1961. For pulses the situation was not much better, while roots and tubers compensated somewhat. Although the harvested area improved - but not yet to 2006 levels - Kenya's basic food production in 2009 reached alarmingly low levels and the country could only potentially feed 72% of its population of 39 million at WHO food requirement levels (and again assuming 65% energy coverage by staple foods, see Annex 1). By 2009, total food energy in Kenya had dropped 19% compared to 2006 and this is at least partly related to the 2007/2008 troubles.[6] After 2009, the agricultural situation

[6] 2006: population: 36.941 million; cereals: 3.937mT (at 3100 kcal/kg = 12.2 bkcal; pulses: 0.747 mT (at 3400 kcal/kg = 2.5 bkcal) and roots and tubers: 3.827 mT (at 950 kcal/kg = 3.6 bkcal). Together: 18.4 bkcal > per capita 503,000/yr or 1378/day. If that is 65% of energy requirements and average needs per day would be assessed to be 2200 kcal/day this would cover 96% of total food energy needs.
2007: population: 37.485 million; cereals: 3.614 mT = 11.2 bkcal; pulses: 0.626 mT = 2.1 bkcal; roots and tubers: 3.424 mT = 3.3 bkcal; together: 16.6 bkcal = 1211 per capita/day or (at 65%): 85% of food energy needs.
2008: population: 38.455 million; cereals: 2.866 mT = 8.9 bkcal; pulses: 0.417 mT = 1.4 bkcal; roots and tubers: 4.574 mT = 4.3bkcal; together: 14.6 bkcal = 1044 per capita/day or (at 65%): 73% of food energy needs.
2009: population: 39.462 million; cereals: 2.899 mT = 9.0 bkcal; pulses: 0.593 mT = 2.0 bkcal; roots and tubers: 4.073 mT = 3.9 bkcal; together: 14.9 bkcal = 1033 per capita/day or (at 65%): 72% of food energy needs.
The 65% figure is explained in Annex 1.

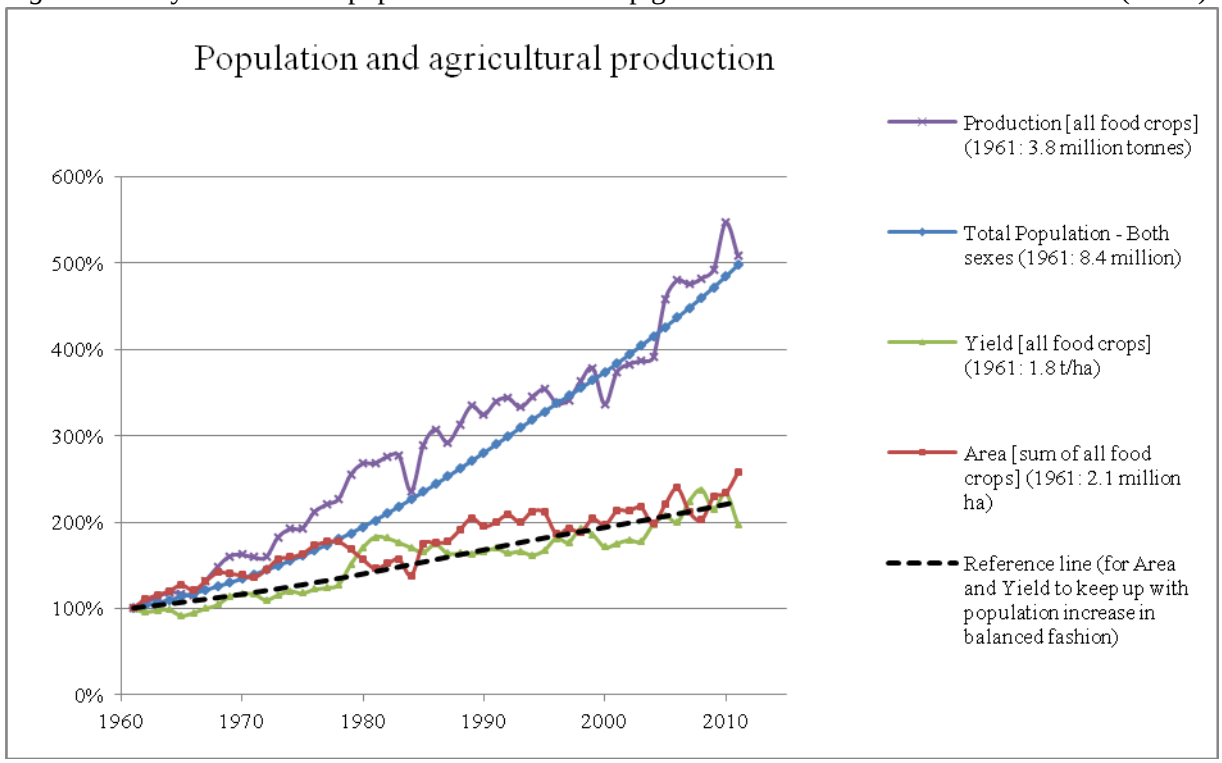
started to normalise and in 2011 Kenya could feed 88% of its population based on its own agricultural production, again assuming that basic food would cover 65% of all dietary requirements (see Figures 6 and 7 and Table 1).

Figure 6: Kenya 1961-2010: population figures, cropping area and crop yield



Source: FAOSTAT data

Figure 7: Kenya 1961-2010: population and food crop growth indexes with 1961 as a baseline (100%)



Source: Derived from FAOSTAT data, see Figure 6.

Table 1: Population and basic food production dynamics in Kenya, 1961-2011

	1961	1970	1980	1990	2000	2011	2011/1961, index
Population (millions)	8.4	11.3	16.3	23.4	31.3	41.6	498
Cropping area (ha of harvested crops, x million)[1]							
Cereals	1.1	1.6	1.8	1.8	1.9	2.7	242
Pulses	0.6	0.7	0.7	1.5	1.2	1.5	229
Roots/tubers	0.1	0.1	0.2	0.2	0.2	0.2	231
Yield (kg/ha x 1000)							
Cereals	1.2	1.3	1.2	1.6	1.4	1.5	122
Pulses	0.4	0.5	0.5	0.5	0.4	0.5	122
Roots/tubers	7.0	7.7	7.4	9.7	7.1	15.4	219
Total basic food production (million tons)							
Cereals	1.4	2.1	2.2	2.8	2.6	4.1	295
Pulses	0.3	0.3	0.4	0.8	0.5	0.8	280
Roots/tubers	0.8	1.0	1.2	1.6	1.6	3.8	505
Food energy value of crop mix (kcal/kg) [recalculated from FAOSTAT] [2]							
Cereals	3137	3136	3111	3101	3083	3124	100
Pulses	3414	3401	3405	3418	3414	3410	100
Roots/tubers	962	966	988	899	913	982	102
Weighed total [inferred]	2484	2547	2468	2458	2360	2202	89
Food energy value (kcal/capita/year x 1000)							
Cereals	516	582	427	369	256	305	59
Pulses	112	104	73	113	52	63	56
Roots/tubers	87	83	72	62	48	90	103
Total	716	770	572	544	356	458	64
Food energy value (kcal/capita/day)							
Cereals	1414	1595	1168	1010	700	834	59
Pulses	307	285	201	309	143	173	56
Roots/tubers	239	227	198	171	131	248	103
Total	1960	2107	1567	1489	974	1255	64

Source: Population data as used by FAOSTAT are from the World Population Prospects: The 2010 Revision from the UN Population Division; all production data: FAOSTAT crop production(final 2011 data, updated: 08 August 2013, accessed on 19 September 2013 from http://faostat.fao.org/site/567/default.aspx#ancor); food energy values recalculated from FAOSTAT Food Balance Sheets.

Notes:

1 Roots and tubers are mainly potatoes, cassava and sweet potatoes in Kenya. Cereals are mostly maize, sorghum, wheat and millet as well as some rice. In 1961 sorghum and millet accounted for 20% of total cereal acreage; in 2011 it was only 14%; maize increased from 68% to 80%.

2 These values have been recalculated by the authors from the food supply statistics in the Food Balance Sheets, which FAOSTAT gives in kg/capita/year and in kcal/capita/day. The resulting imputed values are lower than the values for the raw (unprocessed) foods found in regular food composition table (making due allowance for inedible peels). It is not clear from the FAOSTAT website, what corrections were factored in and how the amounts produced have to be interpreted: do the amounts produced include the amounts consumed in immature or fresh state (e.g. maize eaten fresh from the cob, fresh beans), or are all quantities expressed in mature equivalents (dry equivalents in the case of cereals and legumes). Furthermore, this raises questions about what losses are considered among the category "Waste" in the Food Balance Sheets, and how FAOSTAT can treat "Processing" as a "disappearance", when part of it "appears" again as available for human consumption in modified form (e.g. in the form of flour or bread made from cereal grain). In the early days of the Food Balance Sheets work, FAO published them in book form in tables where all these transformations were recorded explicitly (e.g. FAO, Food Balance Sheets,1964-66 average, published in 1971).

Kenya cannot afford its current low levels of food sufficiency. Over the past 50 years, the production of most basic food crops did not keep pace with population growth and the basic crops which did (potatoes, sweet potatoes, rice and beans) did so more through area increase than through yield increase (see Table 2a). Kenya's attempts to develop non-food crops were partly successful: its non-basic food area went up from 18% of its total crop area in 1961 to 21% in 2011 (see Table 2b). Of course, Kenya's tea production has been a textbook success story, and the expansion of its various oil crops (seed cotton, oil palm, coconut) is also worth mentioning while the increases in production of sugarcane, fruits and vegetables (partly for the export market) can also be seen as major successes. But these cannot compensate for the lack of basic food security and the last few years have been quite alarming for Kenya's food-security situation. Kenya's total agricultural land increased from 4% of its 569,140 km² to 10%, but most of the remaining land is arid or semi-arid and regarded as too risky for agriculture or reserved for wildlife parks.

Table 2a: Kenya: more detailed food crop statistics for staple crops with at least 25,000 t production in 1961: comparison 1961 and 2011

*In **bold** food crops with production growth faster than population growth for the fifty-year period as a whole (which almost quintupled: 2011/1961 index=498).*

Crop	Harvested area (x 1000 ha)			Yield (x kg/ha)			Production (x m kg)		
	1961	2011	2011/ 1961 index	1961	2011	2011/ 1961 index	1961	2011	2011/ 1961 index
Maize	750	2132	284	1253	1584	126	940	3377	359
Potatoes	27	123	457	7185	19169	267	194	2365	**1219**
Sweet potatoes	25	62	248	5600	12269	219	140	759	**542**
Cassava	55	60	110	7636	11231	147	420	679	162
Beans, dry	115	1037	902	478	557	116	55	578	**1050**
Other cereals (barley, oats, wheat)	124	154	124	1027	2186	213	128	337	264
Sorghum	150	254	169	1093	629	58	164	160	97
Rice, paddy	6	28	438	2270	3968	175	15	111	**766**
Pigeon peas	0	139		0	608		0	84	
Cow peas, dry	0	198		0	412		0	82	
Millet	75	111	148	1733	660	38	130	73	56
Plantains	1	3	250	10000	12400	124	10	31	310
Pulses, nes	530	100	19	415	250	60	220	25	11

Source: FAOSTAT crop production(final 2011 data, updated: 08 August 2013, accessed on 19 September 2013 from http://faostat.fao.org/site/567/default.aspx#ancor).

Table 2b: Kenya's crop groups: harvested area (x 1000 ha), 1961-2011

*In **bold** food crop groups with area growth faster than population growth for the fifty-year period as a whole (which almost quintupled: 2011/1961 index=498).*

Crop	1961	2011	2011/1961 index	highest in
Cereals	1106	2680	242	2011
Pulses	645	1477	229	1995
Roots/tubers	108	249	231	2009
Plantains	1	3	250	2010
Pyrethrum	30	8	27	1975
Fibres	114	61	54	1985
Oil crops	72	247	341	2007
Fruits excl. plantains	54	195	363	2010
Tree nuts	11	35	308	1977
Vegetables	44	162	372	1999
Spices	5	6	126	2005
Coffee	42	160	384	1998
Sugarcane	18	64	363	2010
Tea	18	188	**1058**	2011
Tobacco	0	23	**5581+**	2010
Total	*2266*	*5556*	*245*	*2011*
Basic food/Total	*82.0%*	*79.3%*		

Note: Fruits exclude melons; vegetables include melons

Source: FAOSTAT crop production(final 2011 data, updated: 08 August 2013, accessed on 19 September 2013 from http://faostat.fao.org/site/567/default.aspx#ancor).

Livestock and fisheries

Kenya's livestock population mirrors its dismal economic performance between 1961 and 2000. Its total livestock and TLU numbers decreased per capita to less than half its 1961 levels in the year 2000. Only the stock of goats and the (relatively small) pig populations grew faster than the (very high) population growth figures. The stock of camels did not keep pace with population growth up to 2010 (see below). Between 1961 and 2000, only the 1980s showed promising livestock development, with growth figures close to population growth. However, the 1990s saw a dramatic decline in numbers (except for pigs and chickens). After 2000 Kenya experienced a rapid recovery, and strongly improved TLU/capita figures, from 0.36 in 2000 to 0.50 in 2011. We also present the data for 2010, which give a more realistic picture for Kenya: 2011 was a drought year in Eastern Kenya, but more dramatic even in south-eastern Ethiopia and Somalia, and it is likely that camels (and cattle) from the neighbouring countries were brought to Kenya. As a livestock country – and one with the highest livestock numbers per capita in Africa in the 1960s – Kenya's livestock dynamics show a country in distress in the period up to 2000 and some recovery afterwards (see Table 3a). What is also particularly noteworthy is the considerable growth of goats and sheep numbers between 2000 and 2010. It is unclear, though, whether these are a result of differences in estimation techniques (the statistical services in Kenya were not particularly up to standard in the 1990s).

Table 3a: Kenya's livestock (x million), 1961-2011

*In **bold** animals with stock growth faster than population growth for the fifty-year period as a whole (which almost quintupled: 2011/1961 index=498).*

Year	1961	1970	1980	1990	2000	2010	2011	2011/1961
Cattle	7.2	8.6	10.0	13.8	11.7	17.9	18.2	252
Sheep	4.3	3.9	5.0	9.0	7.9	17.5	17.8	414
Goats	4.7	4.2	8.0	10.2	9.9	28.3	28.9	**614**
Camels	0.4	0.5	0.6	0.9	0.8	1.3	3.1	**883**
Pigs	0.1	0.1	0.1	0.1	0.4	0.3	0.3	**600**
Total	16.6	17.3	23.7	34.0	30.7	65.3	68.3	411
Chickens	8.0	11.9	16.4	25.2	26.3	30.4	39.8	497
Total TLU	6.4	7.5	9.1	12.7	11.1	18.8	20.9	328
Human population	8.4	11.3	16.3	23.4	31.3	40.5	41.6	498
TLU/capita	0.76	0.66	0.56	0.54	0.36	0.46	0.50	66
Beehives	0.5	0.7	1.1	2.0	2.5	2.5	2.5	**502**

Source: FAOSTAT Live Animals (final 2011 data, updated: 08 August 2013, accessed on 19 September 2013 from http://faostat.fao.org/site/636/DesktopDefault.aspx?PageID=636#ancor); TLU: cattle x 0.7; goats, sheep and pigs x 0.1; camels x 1.0 and chickens x 0.01.

The amounts of fish and fishery products in Kenya grew faster than the country's population, thanks to fresh water fisheries, but the booming growth in the 1980s-1990s has not been sustained, so that the current availability per capita has been decreasing since 2000 (see Table 4b).

Geographically, food production per capita differs considerably in Kenya, as is shown in Figure 8.

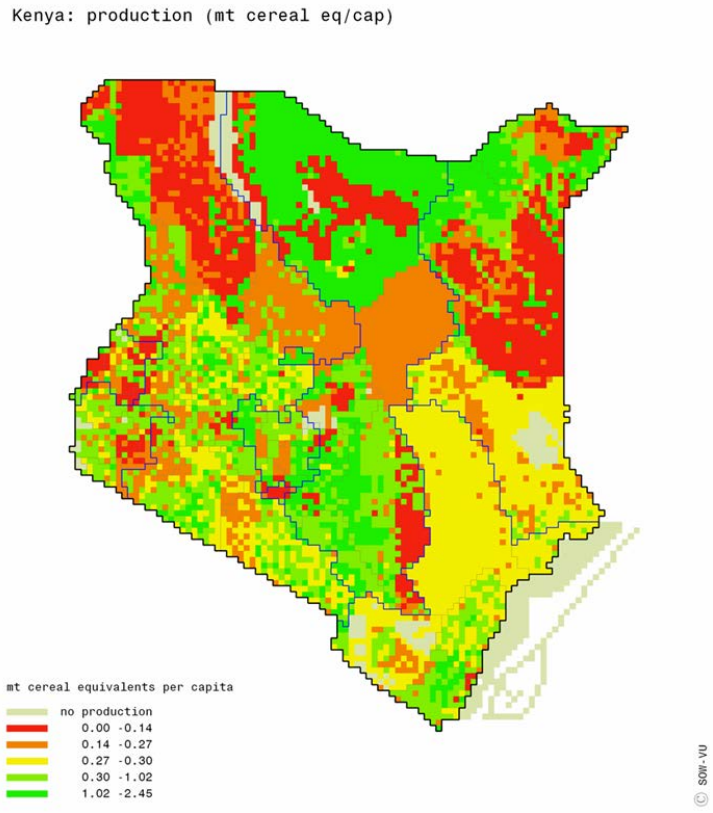


Figure 8: Kenya's food production (ca 2005)

Source: Van Wesenbeeck, C.F.A. & M.D. Merbis (2012), *Africa in Maps, data repository of the food economy in Sub-Saharan Africa*. Amsterdam: Centre for World Food Studies.

Table 4b: Kenya's fisheries (x 1000 tonnes), 1961-2011

*In **bold** fisheries products with growth in catch faster than population growth for the fifty-year period as a whole (which almost quintupled: 2011/1961 index=498).*

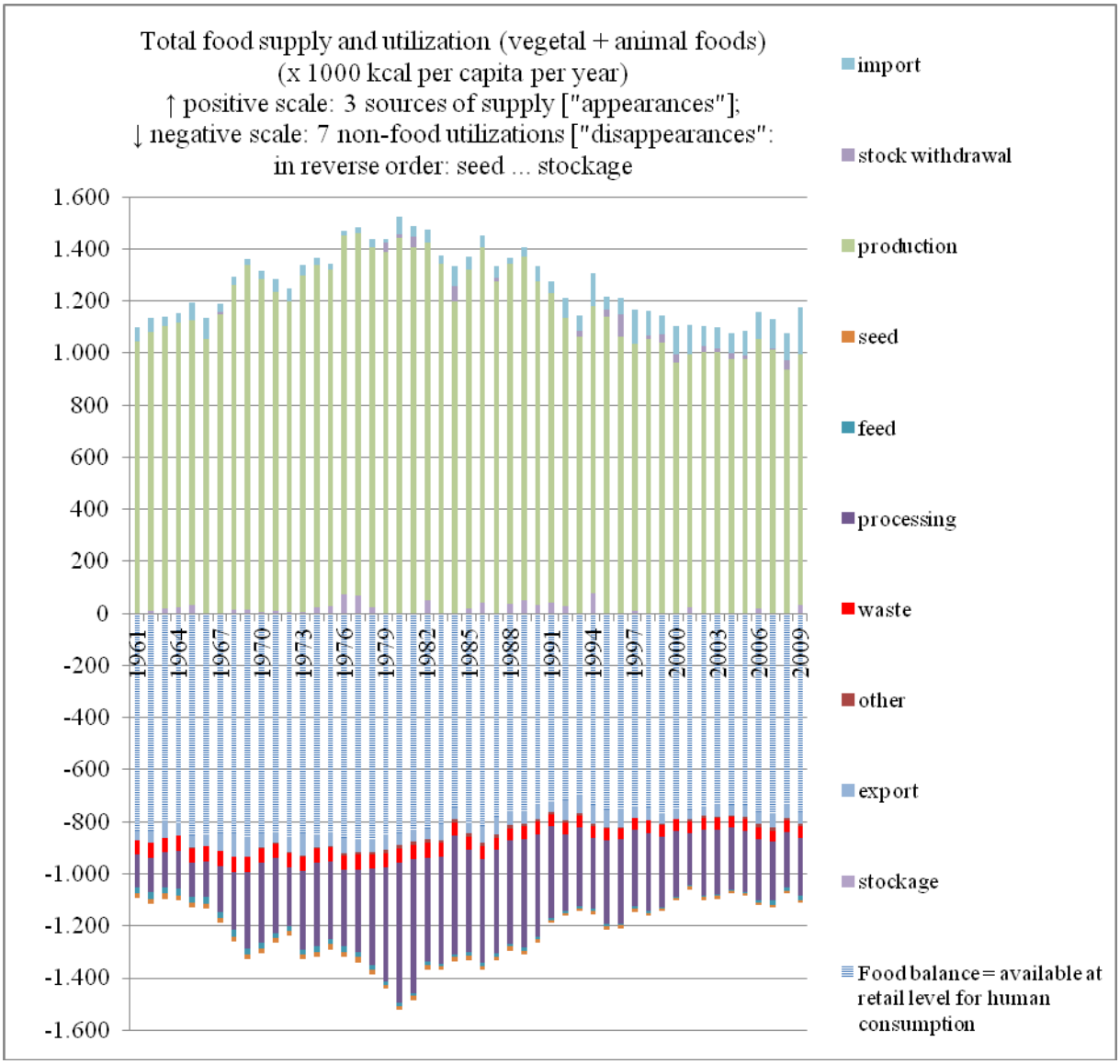
Year	1961	1970	1980	1990	2000	2010	2011	2011/ 1961 index
Human population (millions)	8.4	11.3	16.3	23.4	31.3	40.5	41.6	498
Inland waters								
Crustaceans	0	0	0	87	22	20	18	
Fresh water fishes	8,400	25,800	42,171	191,488	210,683	143,833	196,031	**2334**
Diadromous fishes	410	240	90	427	150	244	442	108
Miscellaneous aquatic animals	0	0	0	2,540	3,460	5,259	5,188	
Sub-total Inland waters	8,810	26,040	42,261	194,542	214,315	149,356	201,679	**2289**
Marine areas								
Crustaceans	0	200	400	960	777	578	559	
Marine fishes	5,100	7,600	5,141	8,966	3,806	7084	5,874	115
Miscellaneous aquatic animal products	0	100	86	198	254	174	183	
Miscellaneous aquatic animals	0	0	10	86	30	22	46	
Molluscs	0	0	1	120	150	583	583	
Sub-total Marine areas	5,100	7,900	5,638	10,330	5,017	8441	7,245	142
Total Kenya	13,910	33,940	47,899	204,872	219,332	157,797	208,924	**1502**
kg/capita	1,664	3,016	2,944	8,738	7,018	3,896	5,021	302

Source: FAO-Fisheries and Aquaculture Information and Statistics Service, accessed on 29 October 2013 from http://www.fao.org/fishery/topic/16140/en

3 Kenya's food balance 1961-2011

Food production and food consumption are connected, but not the same. FAO's food balance data show that food production, imports and stock withdrawal are one side of food availability, but seeds, feed, processing, waste, export and stockage all deduce food available for direct consumption at retail level. Feed and processing can mean indirect food availability, but this can also be (partly) exported. The food production data per capita show the same picture as we have in section 2 (there we looked at all basic foods [from vegetable origin], here at all vegetal and animal foods). Figure 9a gives annual food balance data (per capita per *year*), which are condensed into 3-year averages in Figure 9b. Figure 10 gives the breakdown by food groups (per capita per *day*). The WHO requirements correspond to roughly 800,000 kcal per capita per year, or 2,200 kcal per capita per day (average of all age groups combined).

Figure 9a: Kenya's annual food balance, 1961-2009



Source: FAOSTAT Food Balance Sheets, updated: 29 June 2012 (Accessed 24 June 2013 from http://faostat.fao.org/site/368/DesktopDefault.aspx?PageID=368)

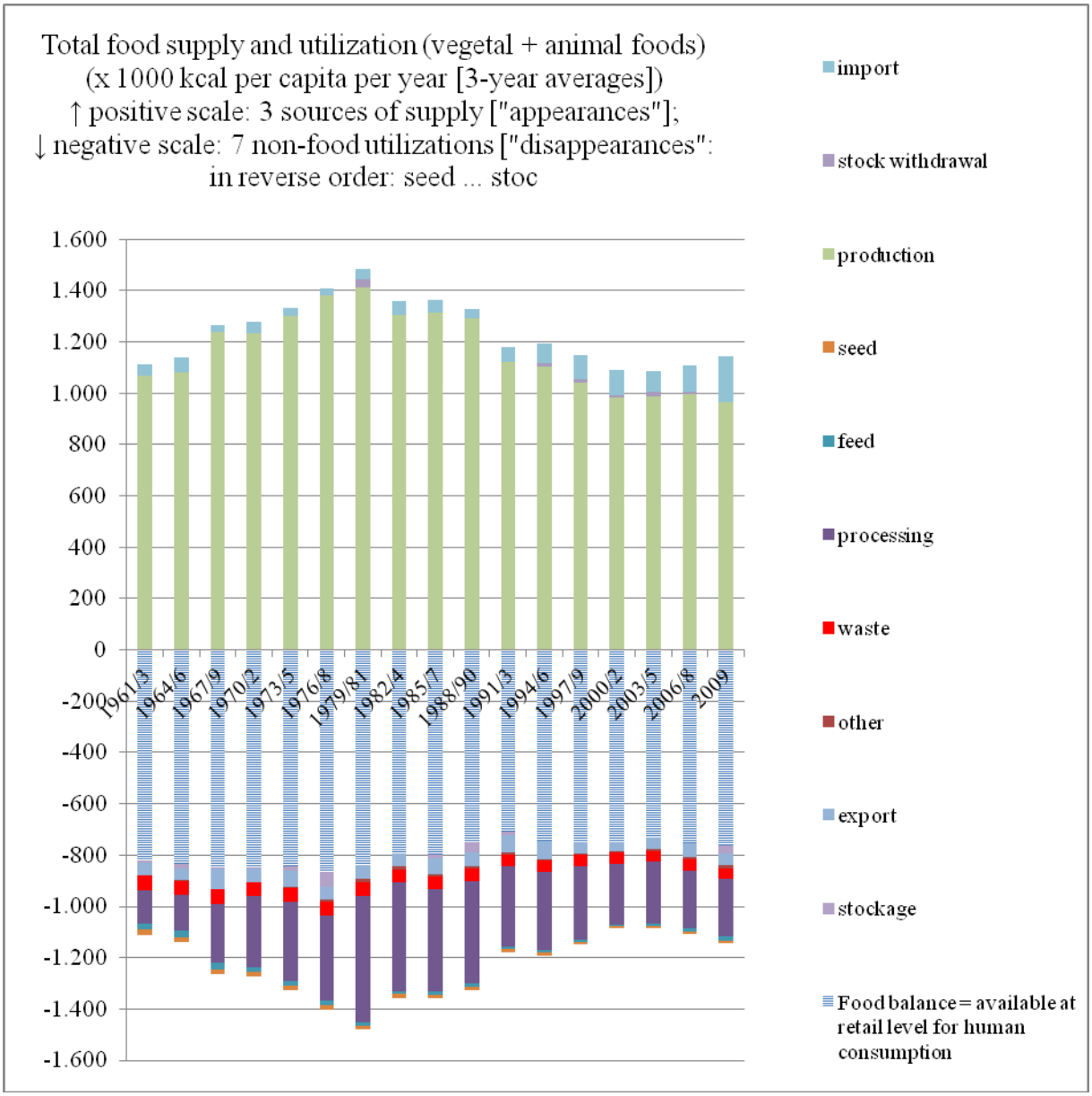
Legend:

- Positive scale - 3 sources of food supply: production + withdrawal from stocks + import;
- Negative scale – 7 'disappearances' into utilizations other than human consumption: putting into stocks + export + other + waste + processing + feed + seed;
- Amount remaining (shaded part: the 'food balance') = *indirect* estimate of food available at retail level for human consumption.

Notes:

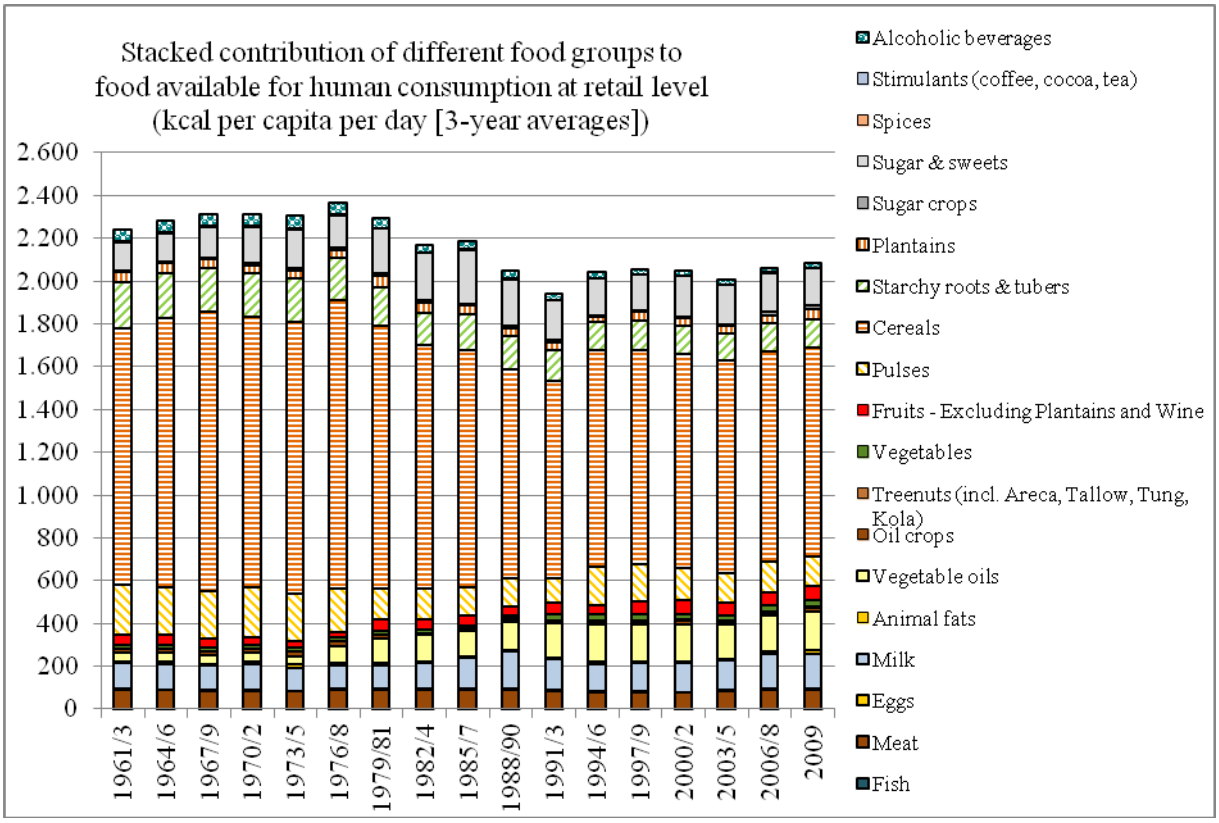
1 2009 is the most recent year for which Food Balance Sheets are available from FAOSTAT.
2 Disappearance data are positive amounts, but in this graph they are represented on the negative scale, adding up to the same total as the food supply.
3 That the legend shows the utilizations in reverse order is due to a technical constraint in constructing this 'mirror image' graph.

Figure 9b: Kenya's annual food balance, 1961-2009 (3-year averages)



Source: FAOSTAT Food Balance Sheets, updated: 29 June 2012 (Accessed 24 June 2013 from http://faostat.fao.org/site/368/DesktopDefault.aspx?PageID=368)

Figure 10: Kenya: food available for human consumption: composition of the food basket at retail level, 1961-2009

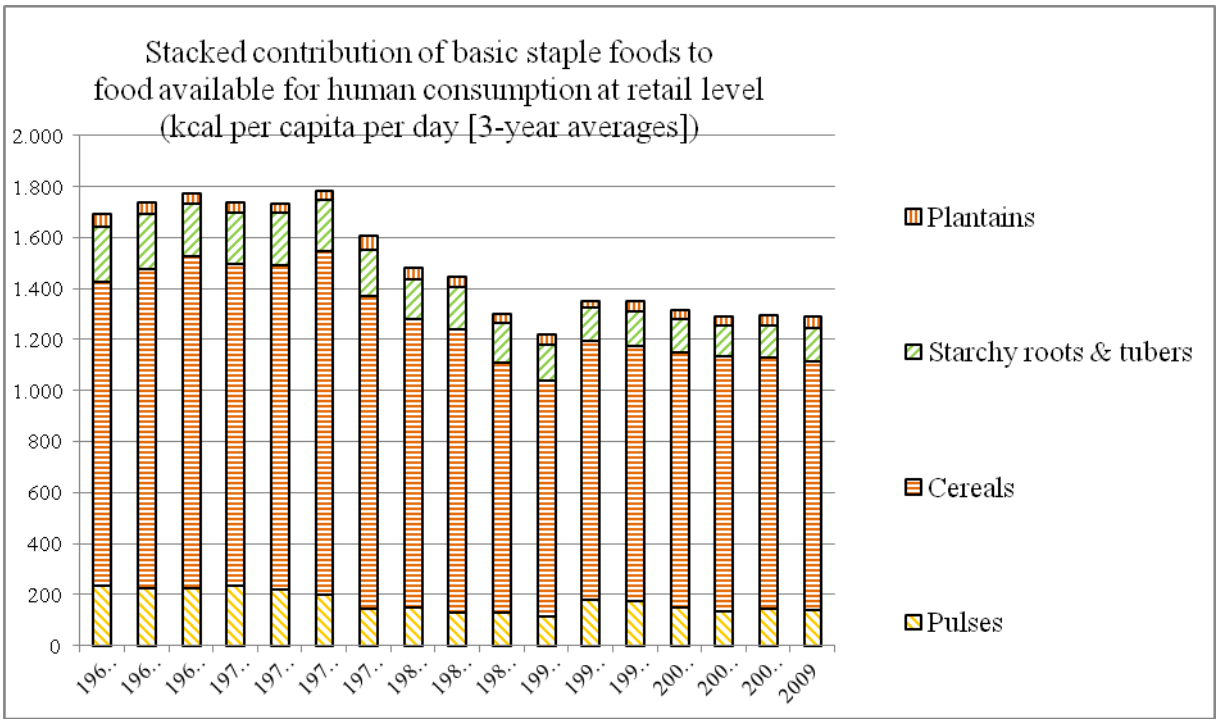


Source: see Figure 9
Note: Stimulants, spices, sugar crops, treenuts, oil crops, eggs and fish are hardly visible due to their small contribution.

Figures 11 and 12 zoom in on the basic (staple) foods and the nutritious non-staple foods, respectively.

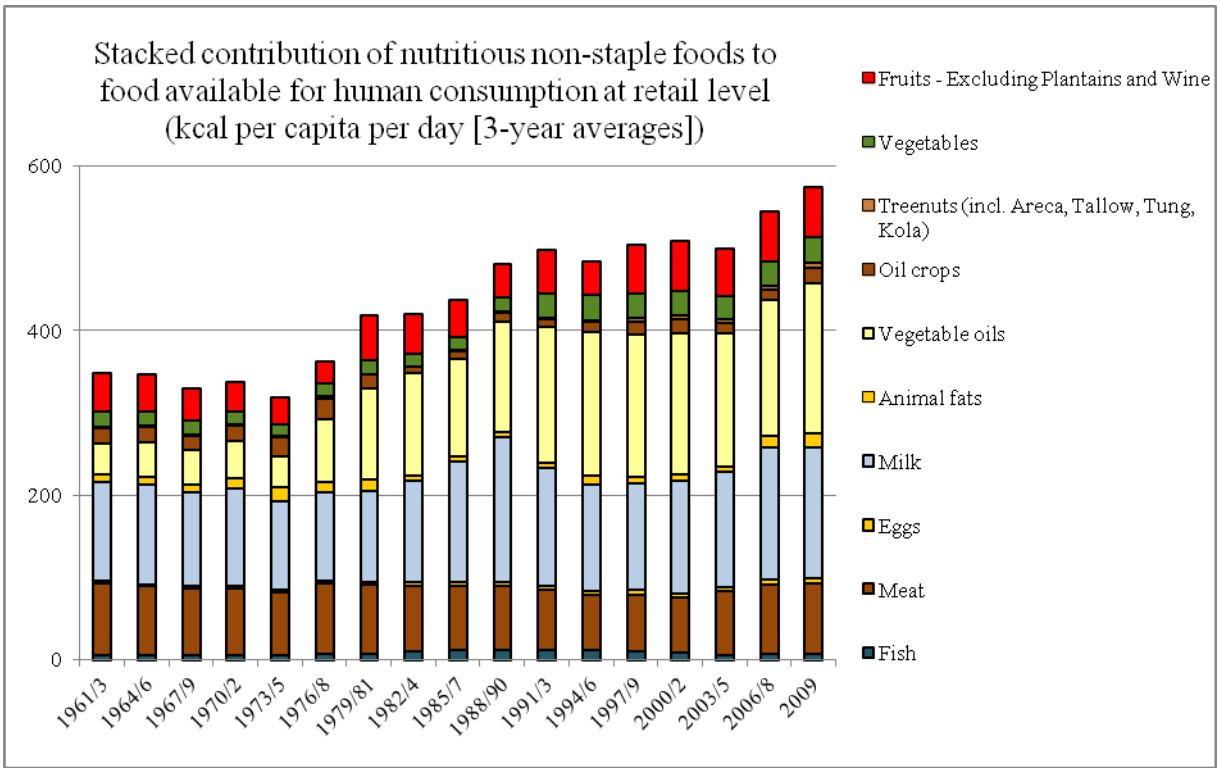
It has to be noted that Figures 9-12 are in terms of dietary energy, not food weight and not nutrient content. Foods that contain a lot of water and little fat (such as fruits and vegetables) contribute less energy for their weight. Their contribution to protein, vitamin and mineral intake is considerably higher than their share in this graph suggests.

Figure 11: Kenya: basic staple food contribution to the diet, 1961-2009



Source: see Figure 9.

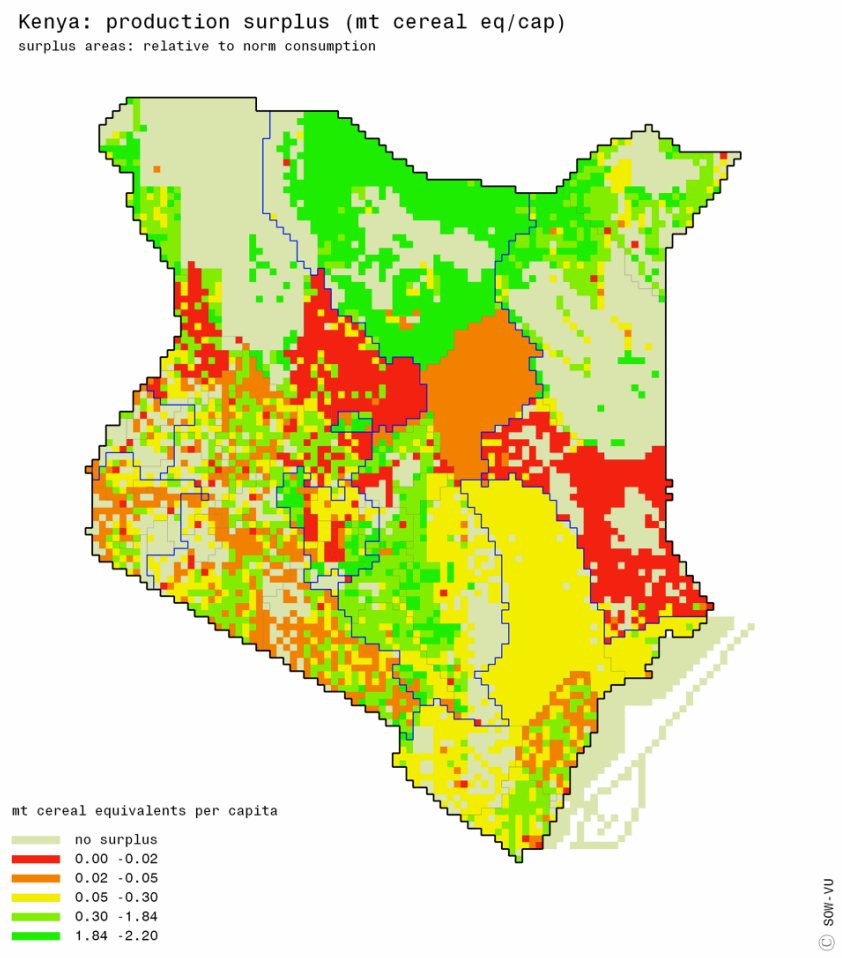
Figure 12: Kenya: Dietary diversity: contribution of nutritious non-staple foods to the diet, 1961-2009



Source: see Figure 9.

Figure 13 presents an assessment of Kenya's food surplus areas, adding geographical specificity to the production part of the food balance data.

Figure 13: Kenya's food surplus areas, ca 2005



Source: Van Wesenbeeck, C.F.A. and M.D. Merbis (2012) Africa in Maps, data repository of the food economy in Sub-Saharan Africa. Amsterdam: Centre for World Food Studies

4 Kenya's most successful agricultural products, 2000-2010

If we look at Kenya's crop production between 2000 (three-year averages for 1999-2001) and 2010 (three-year averages for 2009-2011), we can see major differences in agricultural successes. Tables 4a and 4b show the data for crops and livestock and Table 5 shows a matrix with production growth and yield improvements for crops and additional information about livestock dynamics. Within each cell of Table 5 the crops are presented in the order of magnitude of harvested area around 2010. The cell in the right hand upper corner shows 'promising crops': with total production growth faster than population growth for the decade (index>130%) and at the same time yield increases of 20% or more. For Kenya these are not

Table 4a: Performance of Kenya's major crops 2000-2010[1] (> 45,000 ha in 2010) (population growth 2000-2010[2]: 29.6%)

Crop (per category highest acreage first) Green: Promising crop Red: Problem crop	Ha in 2010 (x 1000)	Production [index number of 2010 compared to 2000] Green >130 Turquoise >120<130 Red <100	Yield [index number of 2010 compared to 2000] Green >130 Turquoise >120<130 Red < 100	Area [index number of 2010 compared to 2000] Green >130 Turquoise >120<130 Red < 100
Maize	2008	128	100	128
Beans, dry	896	136	125	109
Sorghum	218	137	84	163
Tea	173	140	98	143
Cow peas, dry	164	151	109	141
Coffee, green	160	60	64	94
Wheat	141	149	133	109
Pigeon peas	139	112	126	86
Potatoes	122	261	248	106
Millet	105	122	110	110
Pulses, nes[3]	93	88	65	137
Oil seeds, nes[4]	89	112	109	103
Sweet potatoes	74	150	120	125
Bananas	72	139	146	95
Vegetables fresh, nes[5]	67	102	114	90
Sugarcane	66	140	110	127
Cassava	64	107	113	94
Coconut	49	112	39	284
Mangoes, mangosteens, guavas	48	387	132	302

Notes:
1 2000 = average of 1999-2001; 2010 = average of 2009-2011.
2 For population size, estimates for the single years 2000 and 2010 were used.
3 Pulses other than beans.
4 Oil seeds other than sesame, sunflower, seed cotton, groundnuts, linseed and soybeans.
5 Fresh vegetables other than tomatoes, onions, cabbages, chillies, peppers, garlic, green maize, green legumes and watermelons.

Source: FAOSTAT | © FAO Statistics Division 2013 - Updated: 08 August 2013, Accessed on 19 September 2013 (http://faostat.fao.org/site/567)

unimportant crops: beans, wheat, potatoes, sweet potatoes and bananas are crops with a relatively high number of hectares (ca 23% of Kenya's total crop area around 2010). Figures 14-17 portray the growth dynamics since 1961 for the promising crops. As to livestock and livestock products, the promising ones with production increase above 30% during the decade have only modest yield increases (not more than 20%). Figures 18-20 portray the growth dynamics since 1961 for promising livestock (products).

Table 4b: Performance of Kenya's major animals 2000-2010
(population growth 2000-2010: xx%)

Product/Type of animal Green: Promising species Red: Problem species	Number of animals producing or slaughtered in 2010 (x 1000)	Production [index number of 2010 compared to 2000] Green >130 Turquoise: >120<130 Red <100	Weight of milk/meat/eggs per animal [index number of 2010 compared to 2000] Green >130 Turquoise: >120<130 Red < 100	Offtake (% of animals producing or slaughtered out of total stock) [index number of 2010 compared to 2000] Green >130 Turquoise: >120<130 Red <100	Head count [index number of 2010 compared to 2000] Green >130 Turquoise: >120<130 Red < 100
Cow's milk	5,545	170	135	85	148
Goat's milk	3,400	175	97	81	223
Camel milk	50	124	100	57	219
Sheep milk	1,538	102	100	47	219
Hen eggs	18,300	153	112	101	134
Chicken meat	17,500	156	102	113	134
Camel meat	83	110	100	50	219
Goat meat	4,300	118	100	53	223
Sheep meat	2,900	141	123	62	184
Pig meat	195	123	98	131	96
Cattle meat	3,050	172	110	103	148

NB. The index number of total production is the multiplication of the index for head count times the 2 indices for 'yield' (offtake and weight per animal)

Source: FAOSTAT *Live Animals (final 2011 data, updated: 08 August 2013*, accessed on 19 September 2013 from http://faostat.fao.org/site/636).

Table 5: Kenya: successful and less successful crops and livestock species, 2000-2010*

Crops and livestock Yield increases 2000-2010		Production increases 2000-2010		
		<100%	100-130%	>130%
	>130		Pig meat	**Wheat** **Potatoes** **Bananas** **Mangoes**
	120-130		Pigeon peas	**Beans** **Sweet potatoes**
	100-120%		Maize Millet Vegetables, nes Oilseeds, nes Cassava Marine fish[1]	Cow peas Sugarcane **Chicken meat** **Hen's eggs** **Cattle meat** **Cow's milk** **Fresh water fish[1]**
	< 100%	Coffee Pulses, nes	Coconut Camel milk Camel meat Goat meat Sheep milk	Sorghum Tea Goat milk Sheep meat

nes = not elsewhere specified

* In **bold**: most successful crops and livestock species.

[1] For fish no information is available that can be taken as an index of 'yield'.

Figure 14: Wheat as a recently successful crop in Kenya: production dynamics 1961-2011

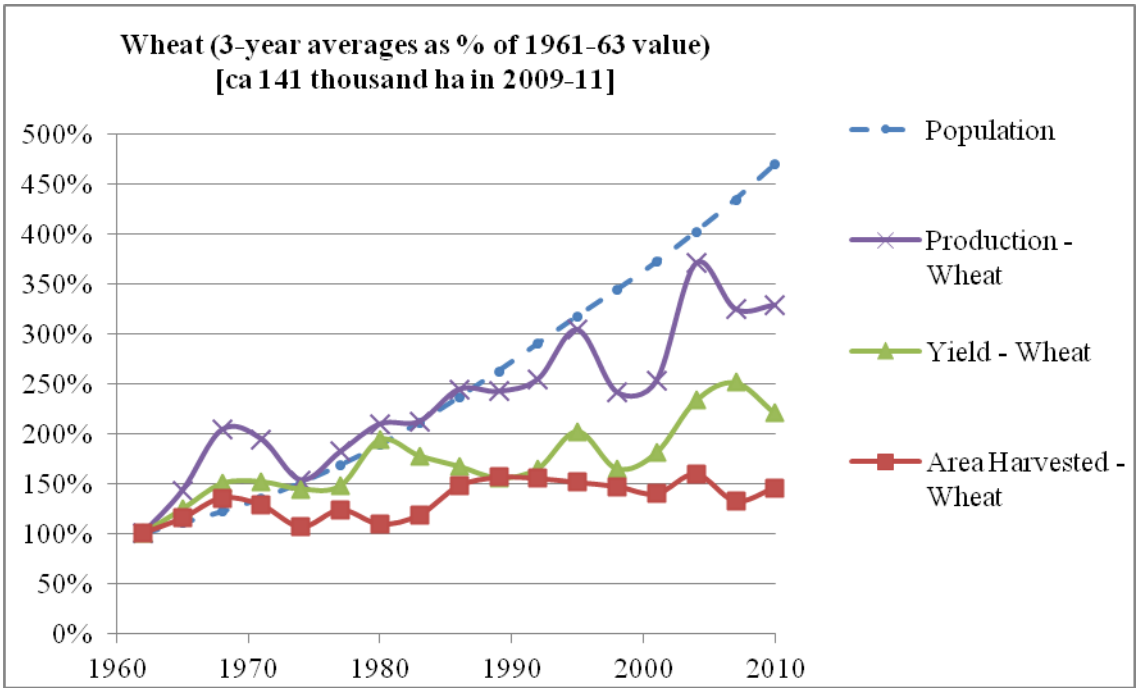


Figure 15a: Potatoes as a recently successful crop in Kenya: production dynamics 1961-2011

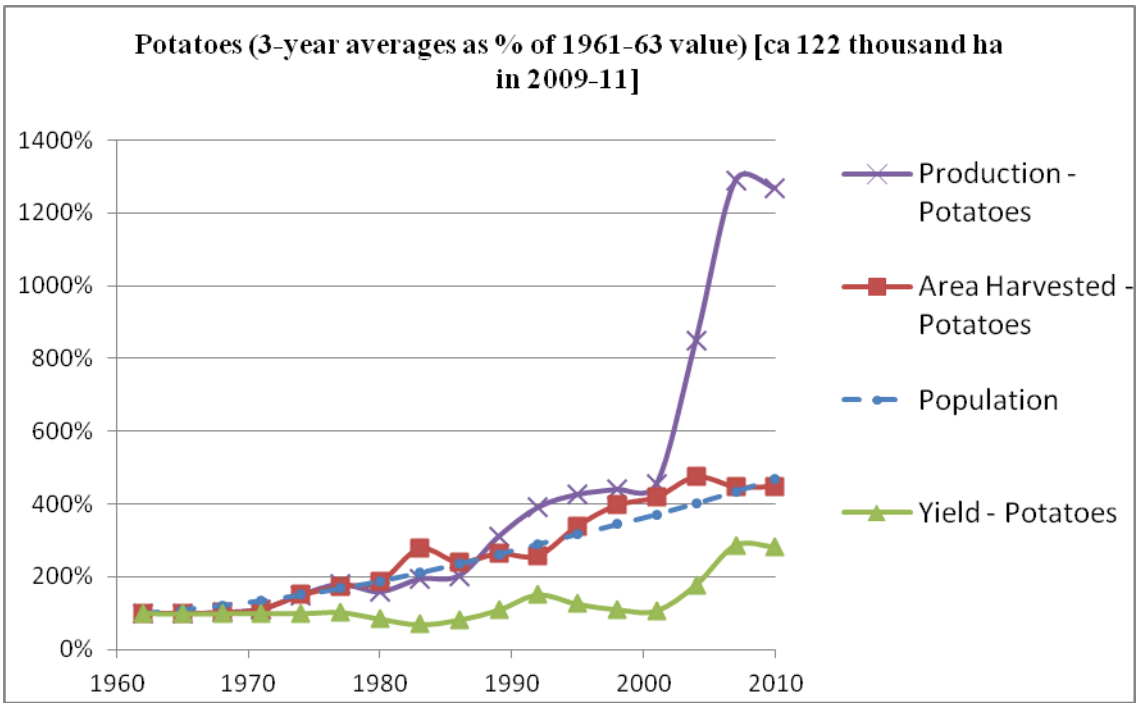


Figure 15b: Sweet potatoes as a recently successful crop in Kenya: production dynamics 1961-2011

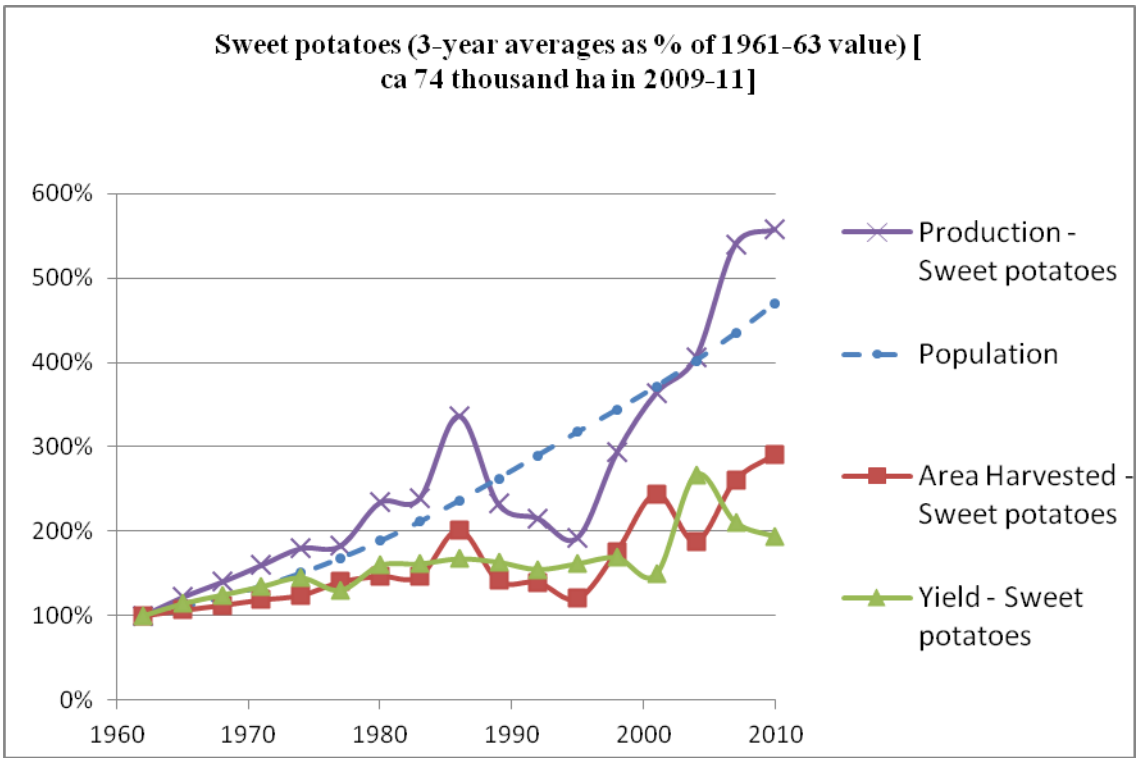


Figure 16a: Bananas as a recently successful crop in Kenya: production dynamics 1961-2011

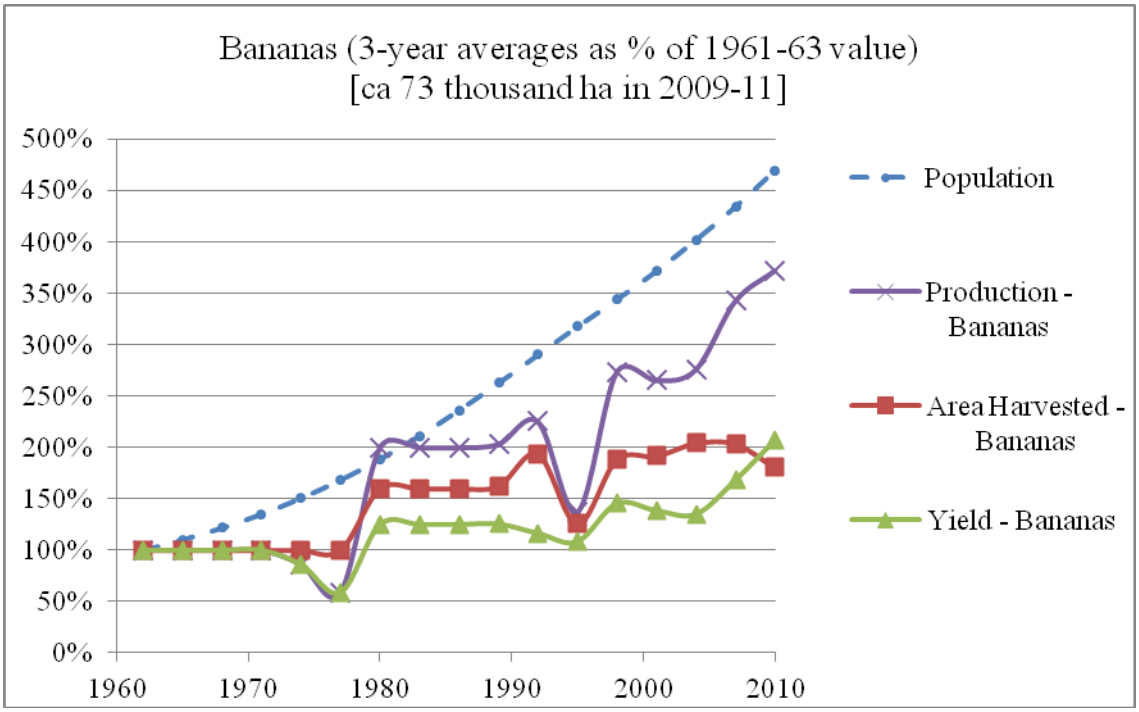


Figure 16b: Mangoes as a recently successful crop in Kenya: production dynamics 1961-2011

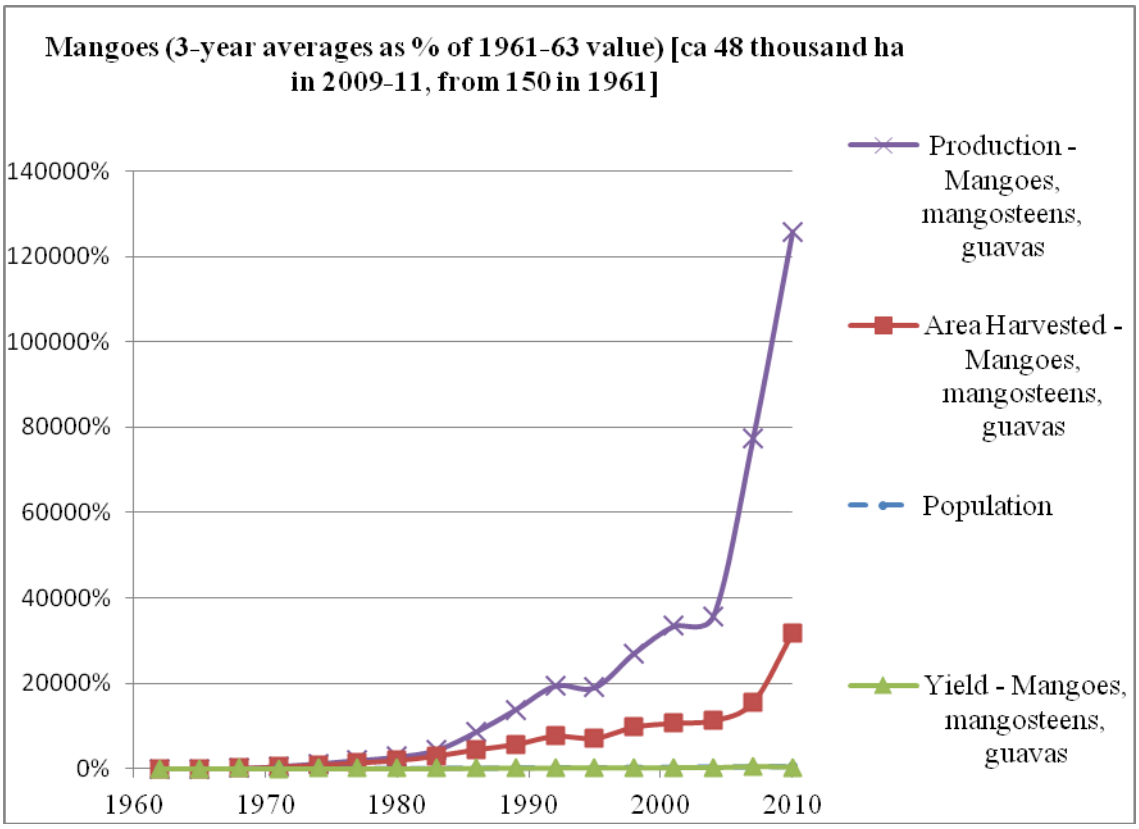


Figure 17: Beans as a recently successful crop in Kenya: production dynamics 1961-2011

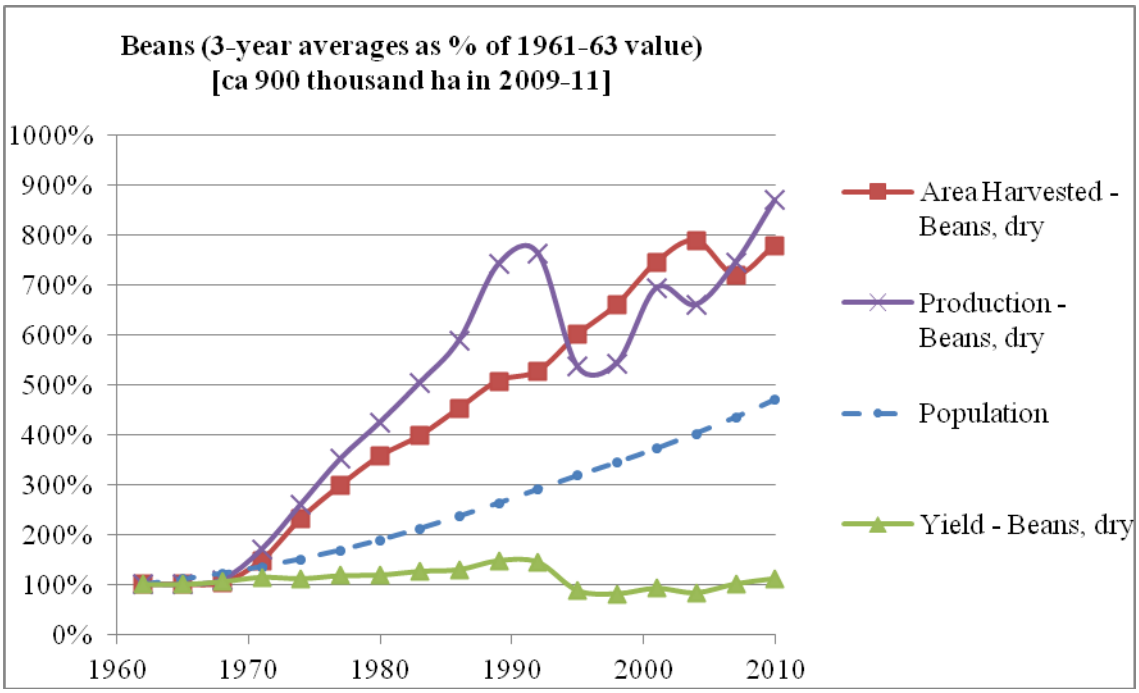


Figure 18a: Cattle as a recently successful livestock species in Kenya: production

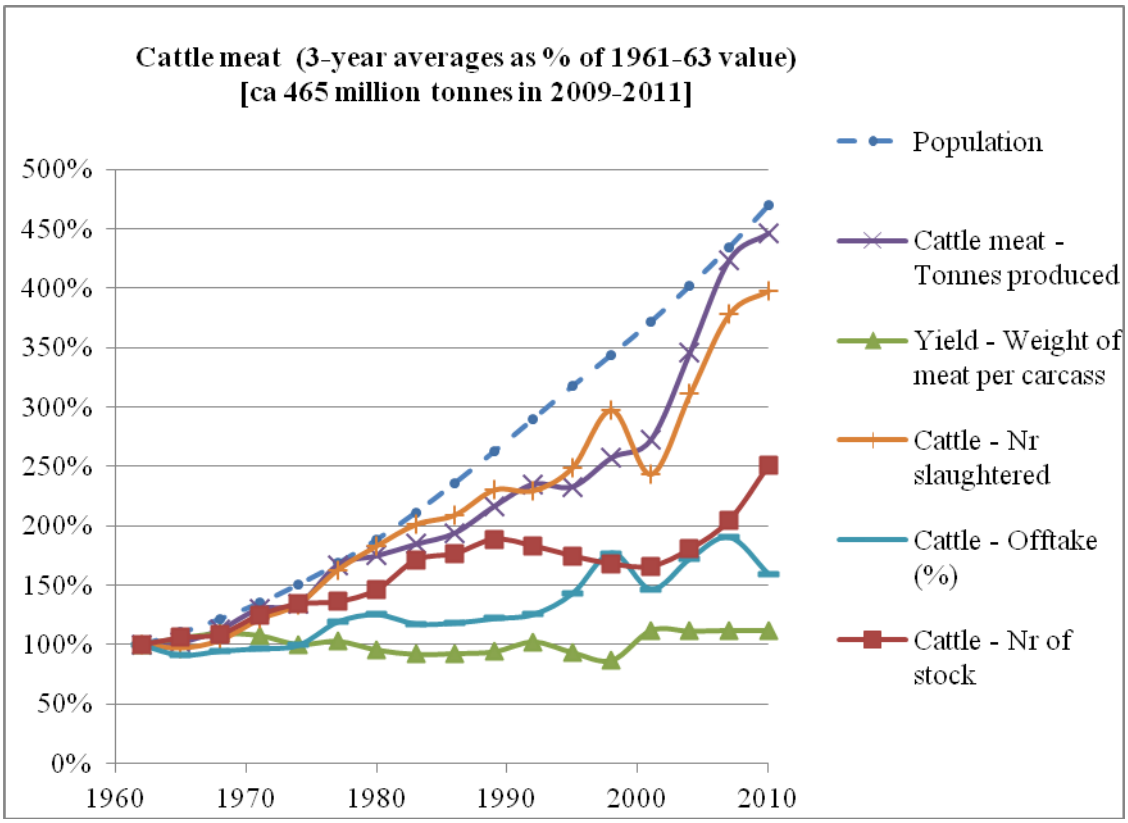


Figure 18b: Cow's milk as a recently successful livestock product in Kenya: production dynamics 1961-2011

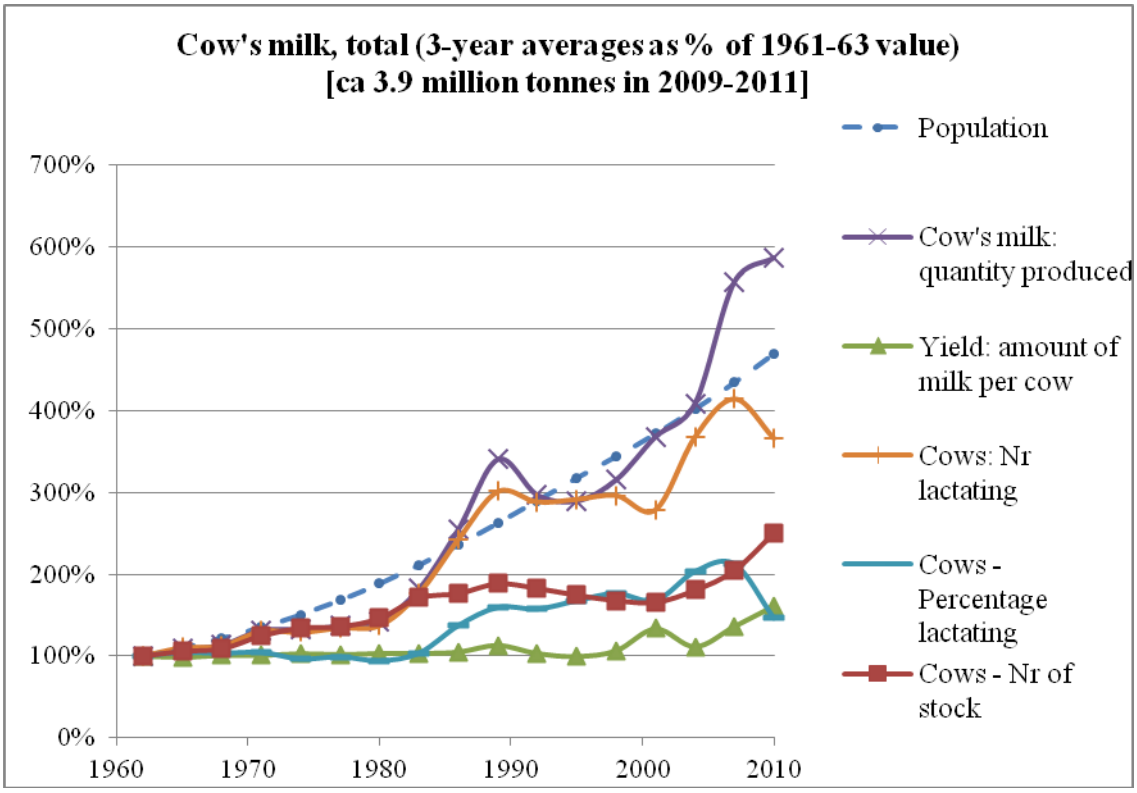


Figure 19a: Chicken as a recently successful livestock species in Kenya: production dynamics 1961-2011

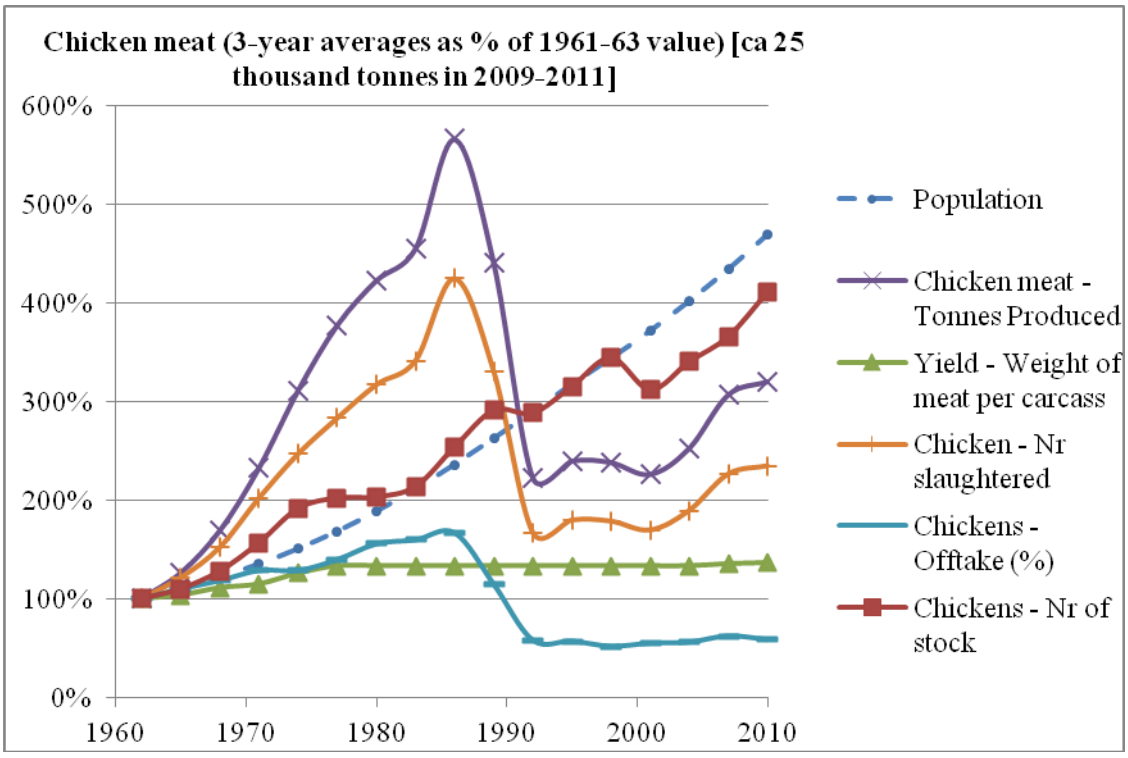


Figure 19b: Hen's eggs as a recently successful livestock product in Kenya: production dynamics 1961-2011

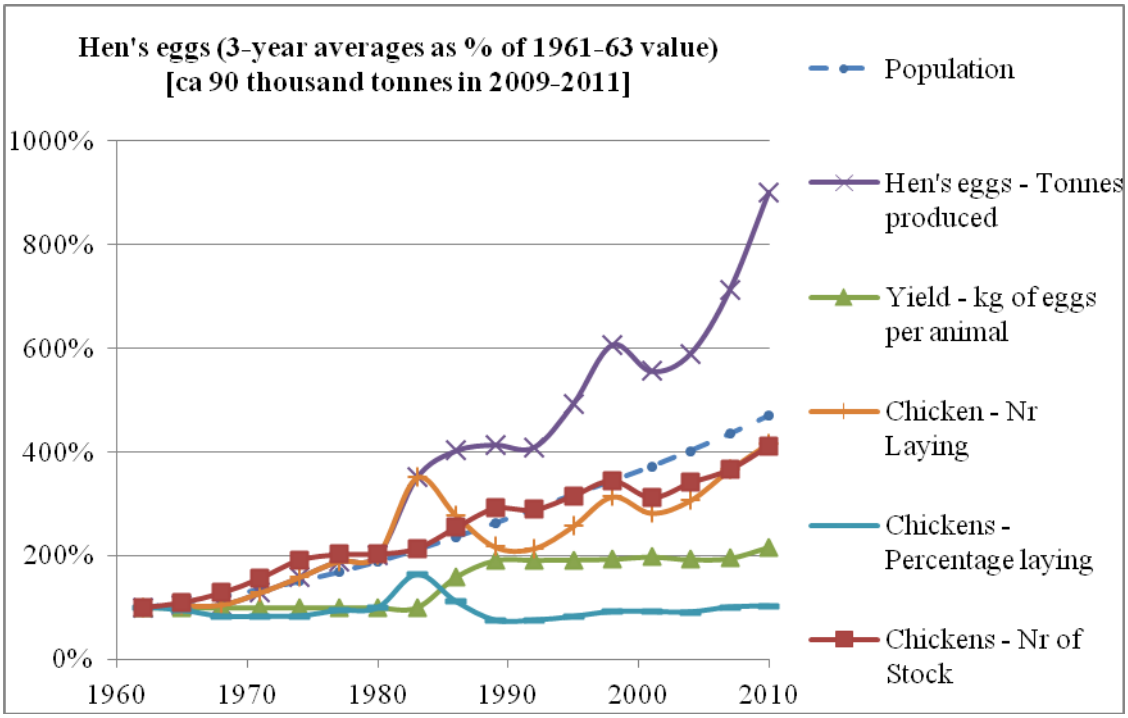


Figure 20a: Pigs as a recently *moderately* successful livestock species in Kenya: production dynamics 1961-2011

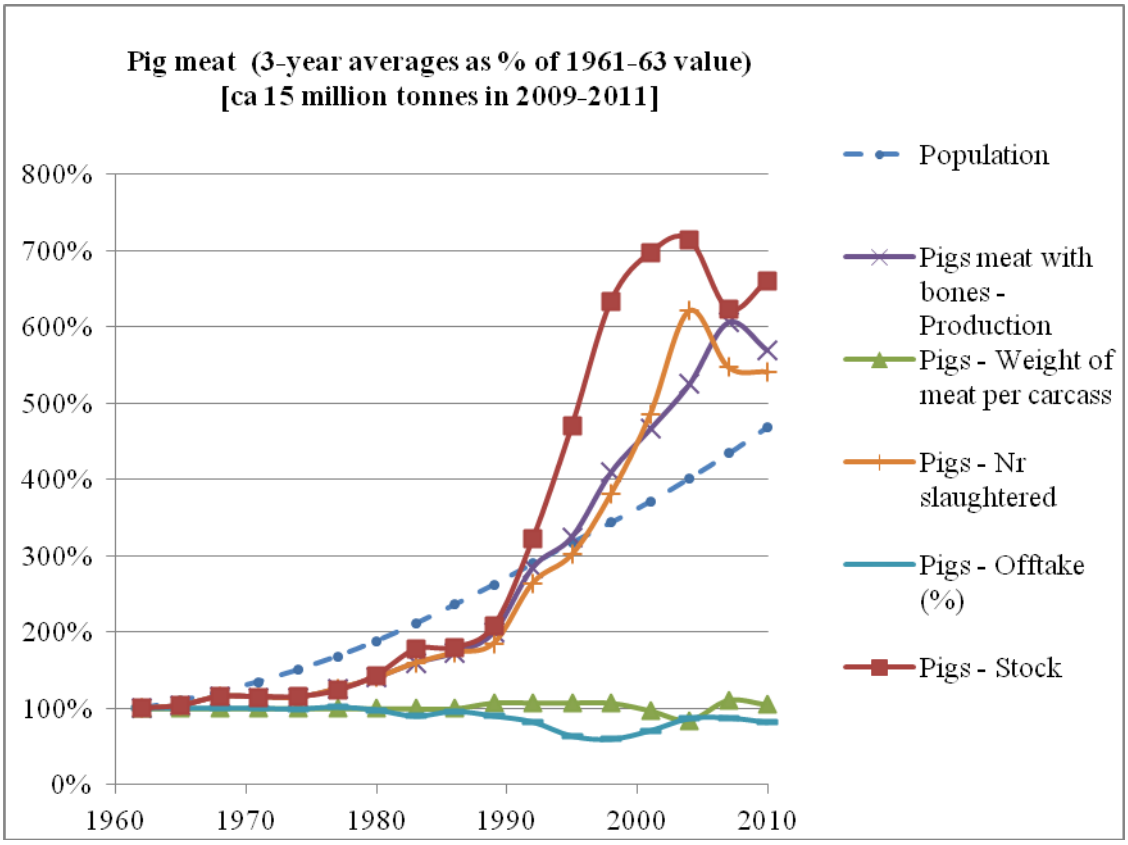
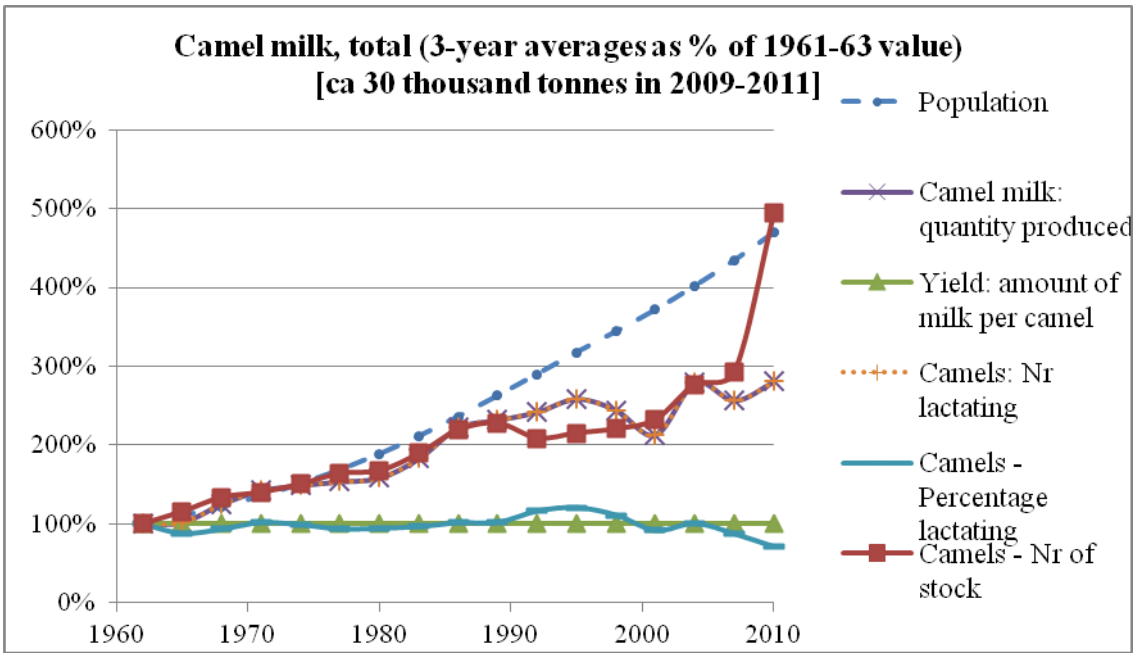


Figure 20b: Camel's milk as a recently *moderately* successful livestock product in Kenya: production dynamics 1961-2011



Note: The index of production almost coincides with the index of the number of lactating camels (as milk yield hardly changed).

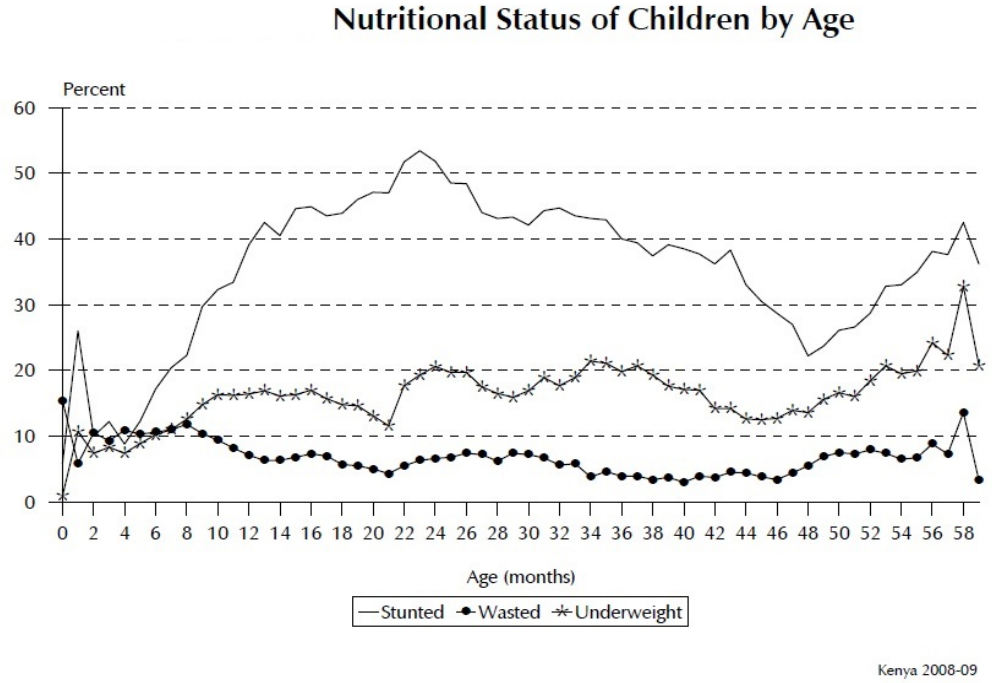
5 Kenya's food security as indicated by child under-nutrition data

In Kenya there have been Demographic and Health Surveys in 1993, 1998, 2003, and 2008-09. For 2000, data are available from the UNICEF sponsored Multi Indicator Cluster Survey (MICS). These give an indication of child under-nutrition and hence of the utilisation pillar of actual food insecurity. The prevalence of low weight-for-height (wasting, thinness) is a measure of acute under-nutrition and is generally highest among the youngest (most vulnerable) babies (see Figure 21); the prevalence of low height-for-age (stunting, shortness) is a measure of chronic under-nutrition, reflecting the accumulation of effects as age progresses: in general it is an irreversible condition that impacts negatively on health and performance once the child has reached adult life. The combined result of wasting and stunting is reflected in the overall indicator: prevalence of underweight - it accumulates, but less so than stunting. Therefore, stunting is now regarded as the indicator of choice of nutrition insecurity. Figure 22 (based on the most recent DHS survey) indicates that the levels of wasting and underweight in Kenya are of medium seriousness as a public health problem and that the level of stunting is considered to be very high. The following graphs (Figures 23-28), give a simultaneous view on the condition of wasting and stunting; the prevalence of underweight (not shown) increases from bottom left to top right in these figures. The closer a data point is to the origin (zero-point), the better is the nutritional condition (see the realistic 'ideal' situation indicated in Figure 27). These graphs show reference values for severity, as follows: prevalences of stunting are qualified as a 'serious problem' of public health significance if

they are between 30 and 40% and 'very serious' if they are beyond 40% (cf Figure 22). For wasting these critical levels are lower (10% and 15%, respectively), due to its nature as generally a temporary episode in a young child's life.

The DHS 2008-2009 results show that acute under-nutrition in Kenya is high. Nationally, 35 percent of children under five are stunted, while the proportion severely stunted is 14 percent. Analysis of the indicator by age group shows that stunting is highest (45.5 percent) in children of 18-35 months old and lowest (11 percent) in children less than 6 months old. Severe stunting shows a similar trend, where children of 18-23 months old have the highest proportion of severely stunted children (22 percent) and those less than 6 months have the lowest proportion (4 percent). Acute under-nutrition (wasting) is high in Kenya in the first year of children's lives; chronic under-nutrition accumulates up to a very serious level by 2-3yrs, and subsides somewhat by 4-5yrs, but remains high. The data for 2008-2009 show that rural under-fives are more undernourished than urban (Figure 25) and that under-five boys are more undernourished than under-five girls (Figure 24). The poorer a household is, the higher the child under-nutrition indicator (Figure 27). Regionally particularly the situation in Coastal and Eastern areas is bad. If we compare the outcomes of 2008/09 with 2003and with earlier surveys (Figure 28), the trend in the nutritional status of young children in Kenya has been that there was a decrease of chronic under-nutrition (stunting) between 2003 and 2008-09, but an increase in acute under-nutrition (wasting). One should take into account, though, that the 2008-09 DHS was done after a period of serious trouble in the country (the post-election violence of 2007/08).

Figure 21: Kenya: under-five children's anthropometric failure (under-nutrition) in 2008-09, by age



Source: Fig 11.1 in Kenya Demographic and Health Survey 2008-09 (Kenya National Bureau of Statistics (KNBS) and ICF Macro. 2010)

Figure 22: Kenya: under-five children's under-nutrition in 2008-09, three indicators of a very bad situation

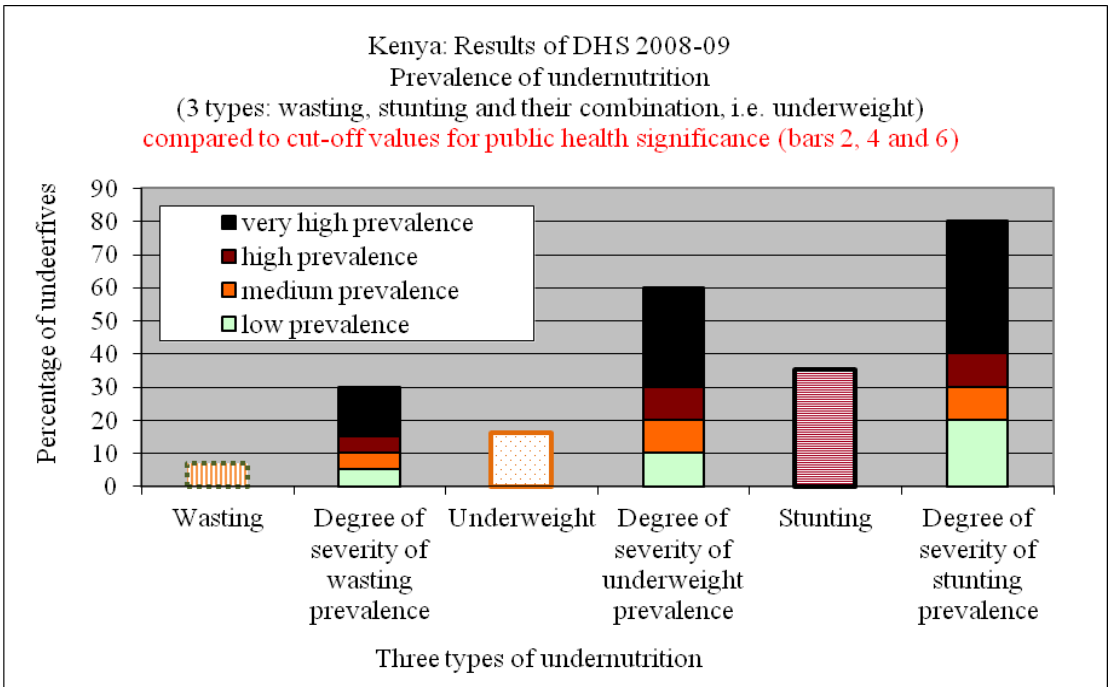


Figure 23: Kenya: under-five children's under-nutrition by age group in 2008-09

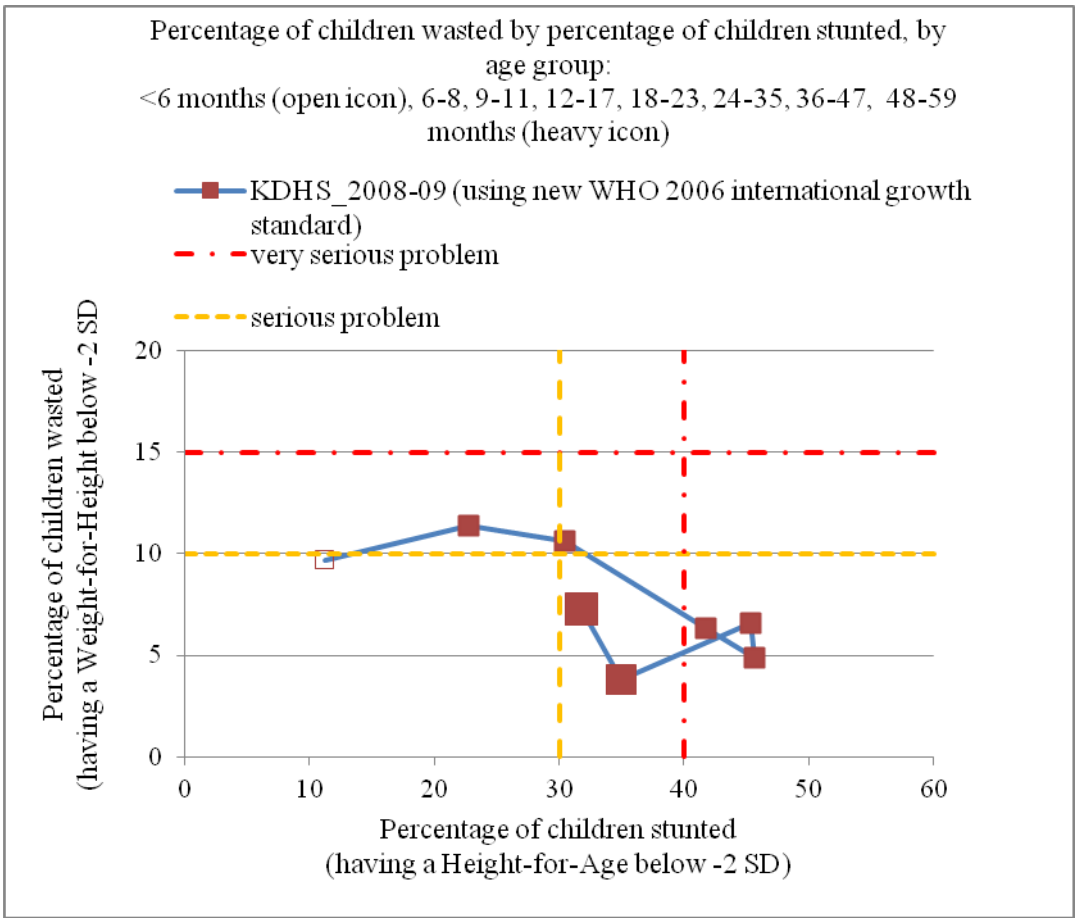


Figure 24: Kenya 2008-2009: under-five children's under-nutrition, differences between boys and girls

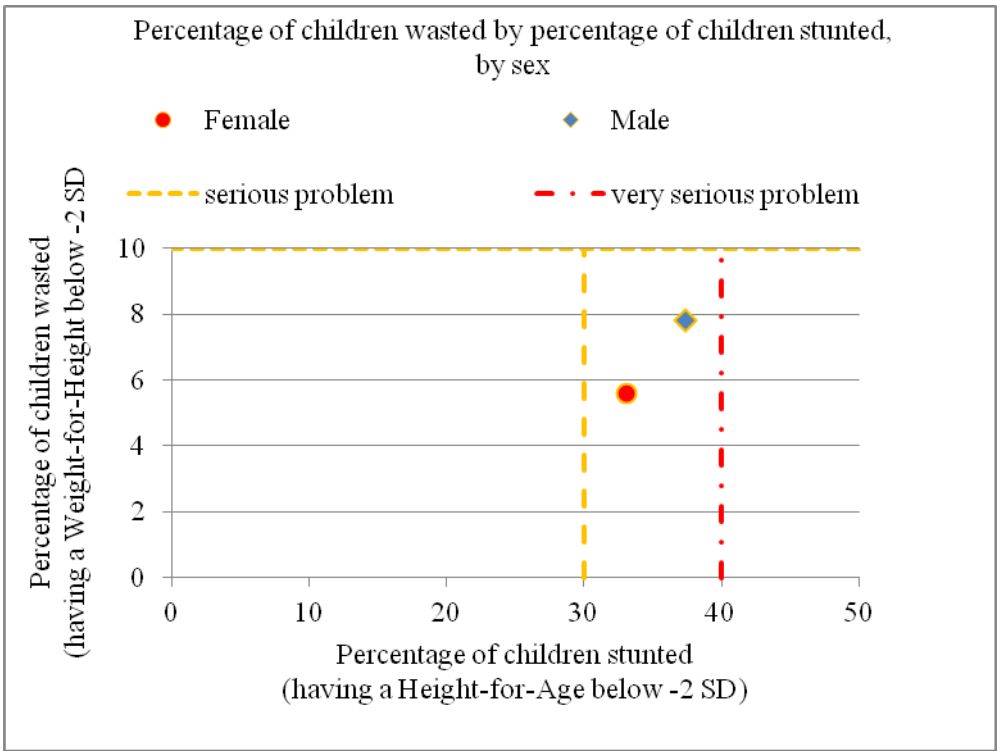


Figure 25: Kenya 2008-09: under-nutrition differences between rural and urban areas

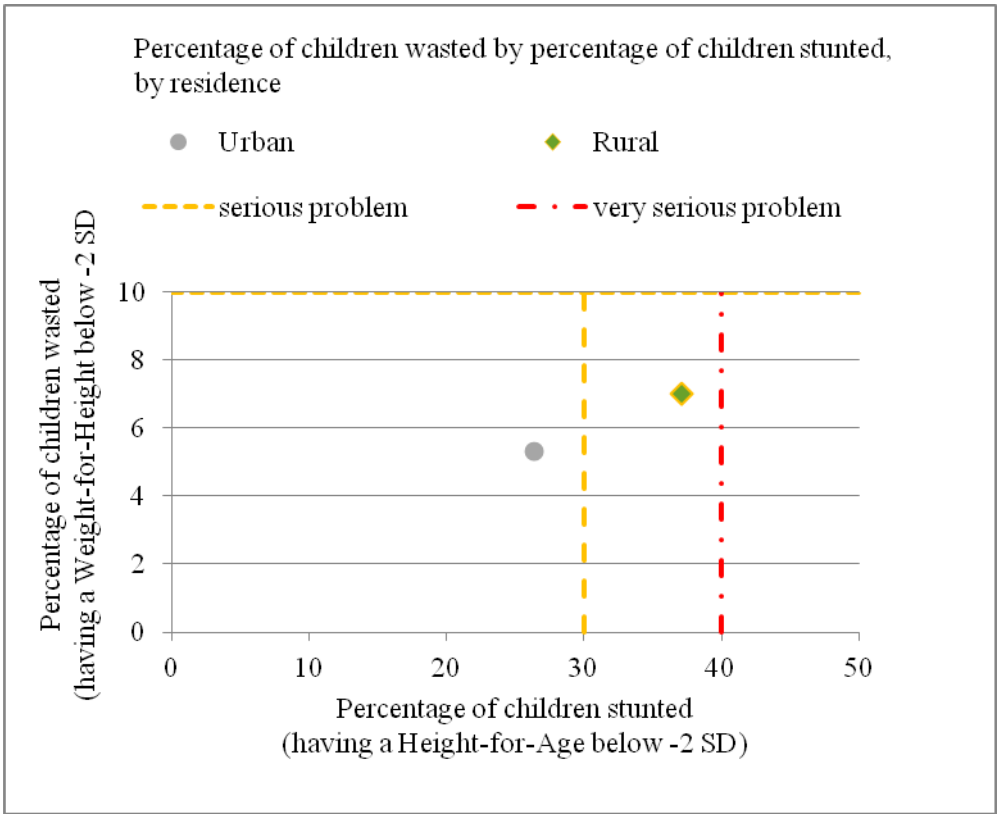


Figure 26: Kenya 2008-2009: under-nutrition differences between regions

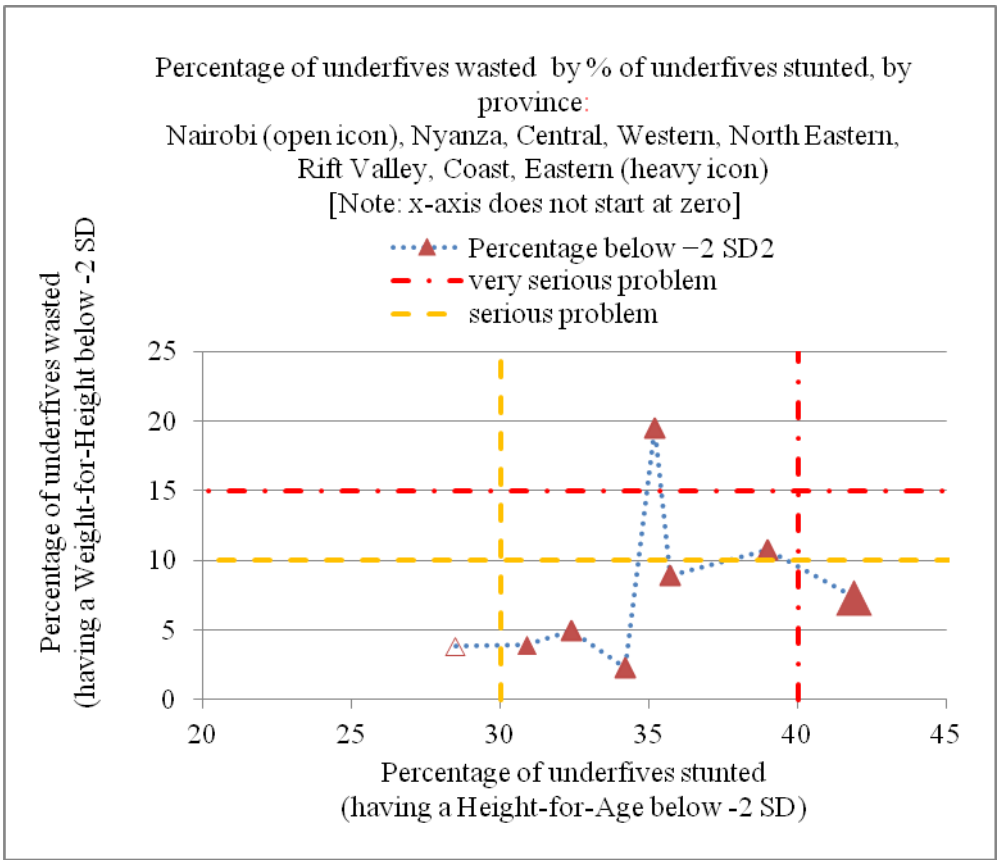


Figure 27: Kenya 2008-2009: under-nutrition by wealth group (income quintiles)

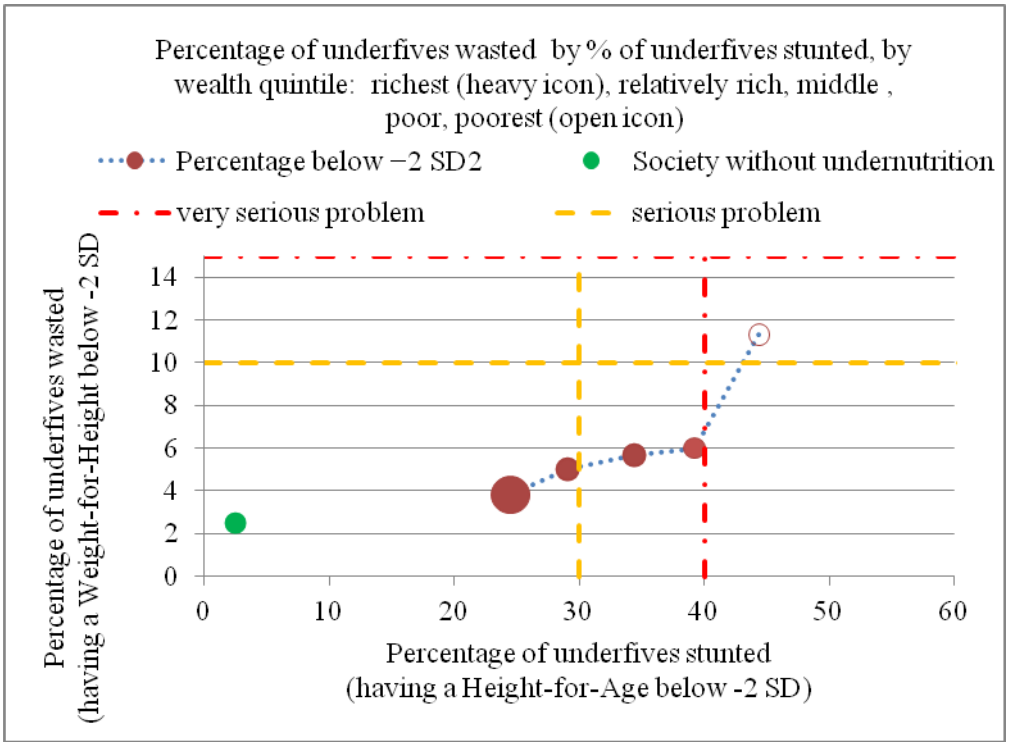
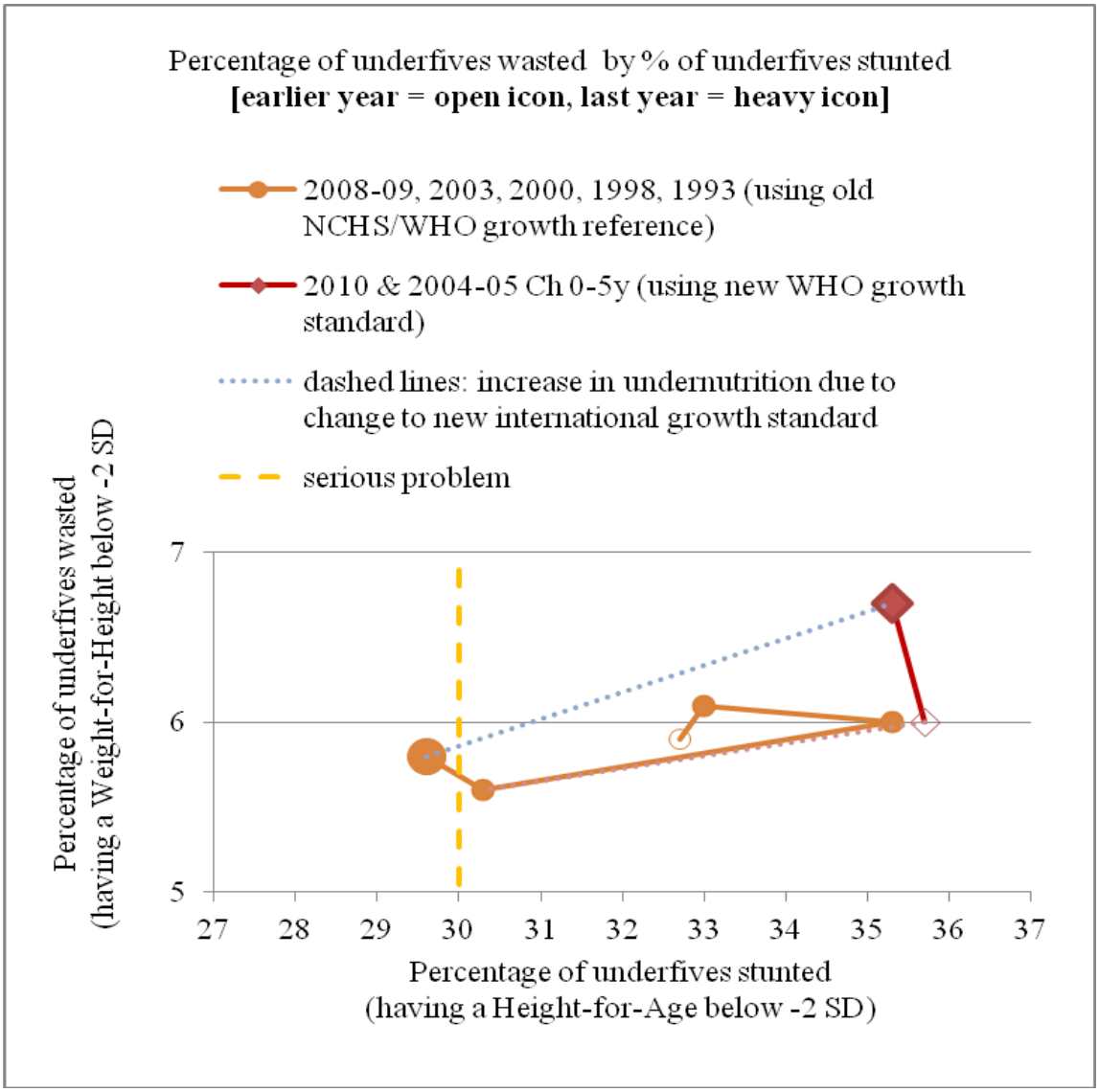
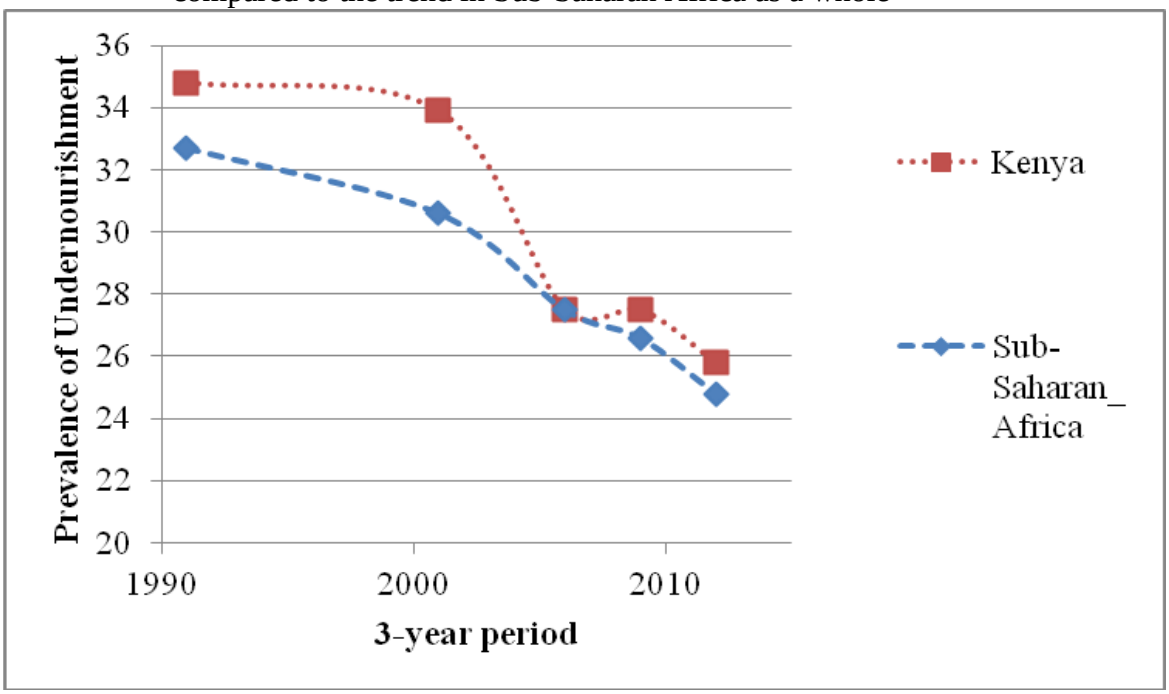


Figure 28: Kenya: under-nutrition dynamics 1993-2008/9 (using old growth reference values) and 2003 - 2008/09 (using new growth standards)



The Food and Agriculture Organization produces an alternative hunger estimate ('Prevalence of Undernourishment' – PoU) based on (i) average aggregate food availability (as per the annual Food Balance Sheets) and (ii) a statistical procedure, based on budget-consumption survey data, to generate a fictitious 'distribution' of that food over income classes. The PoU is an estimate of the number of people (all ages combined) that are chronically hungry in the country in a given year. Figure 29 shows that the prevalence of hungry people in Kenya is above average in Sub-Saharan Africa; the trend in Kenya shows an improvement after 2000-2002, followed by stagnation in the period 2005-2010, with improvement again in 2011-2013.

Figure 29: Trend of the prevalence of undernourishment (PoU) in Kenya compared to the trend in Sub-Saharan Africa as a whole

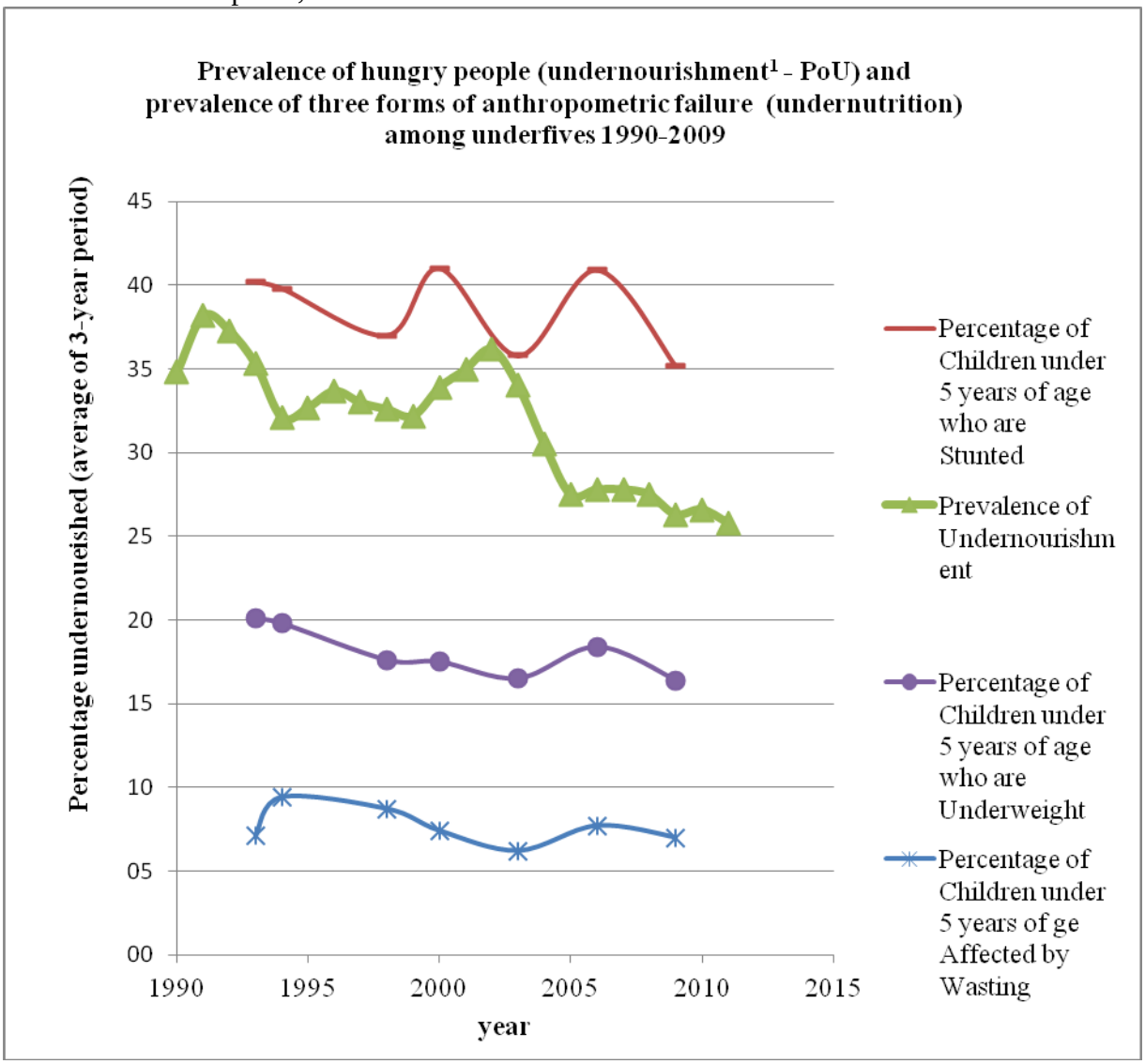


Source: FAO (2013) State of Food insecurity in the World 2013

FAO makes available an Excel sheet containing an international suite of indicators of food insecurity in countries and regions (FAO: Food Security Indicators, release 1 October 2013). Figure 30a, based on this suite, shows that over the period considered (1990-2009), both the food-related and the anthropometrical indicators of food insecurity showed a slight downward trend, which points to an improvement of food access (less hungry people) and of food utilisation (less undernourished young children), respectively.

When comparing on the one hand the trend of hunger (percentage of people having a lack of food) and on the other hand the trends of childhood anthropometric failure, the prevalence of stunting is the preferred indicator, as it shows the effect of chronic under-nutrition which accumulates over several years in the past. Inspection of Figure 30a suggests – at first sight – that the two indicators have their own dynamics which are seemingly unrelated: the peaks and dips in PoU and stunting do not at all coincide. Yet, if one assumes that a change in stunting reflects a change in PoU of say 3-4 years ago, the ups-and-downs in the modified graph (PoU shifted to the right – not shown here) appear to coincide quite fairly. Zooming in on the older children of 3-4 years old, the time-lagged relationship is even stronger, as can be expected (see Figure 30b).

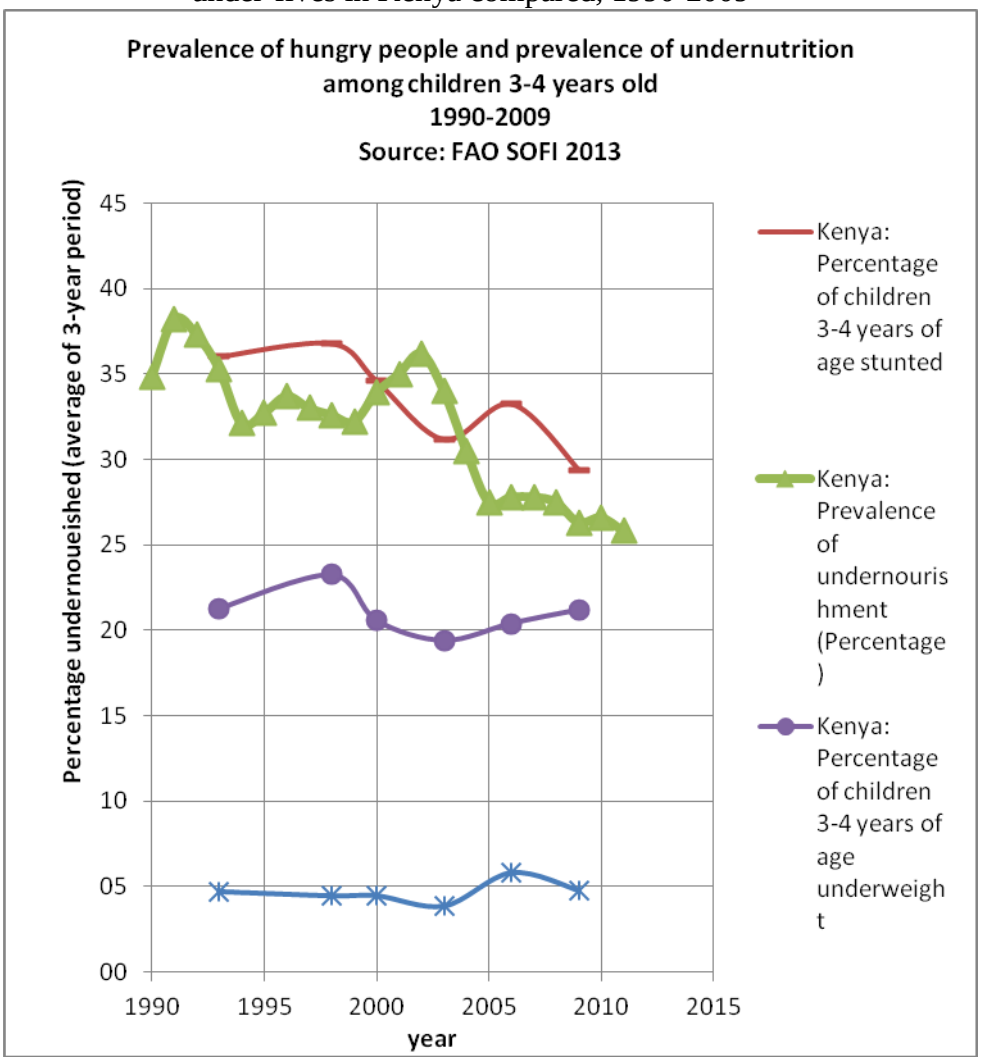
Figure 30a: Trends of hungry people and of under-fives childhood under-nutrition in Kenya compared, 1990-2009



[1] The prevalence of undernourishment (hungry people) is calculated on a 3-year average basis.

Source: FAO (2013), *State of Food insecurity in the World 2013*. This report derives the prevalences of stunting, wasting and underweight from the WHO Global Database on Child Growth and Malnutrition, which uses the new WHO child growth standards of 2006. Prevalences of under-fives under-nutrition from older surveys (using old NCHS growth reference values) were converted into the new system using a published algorithm.

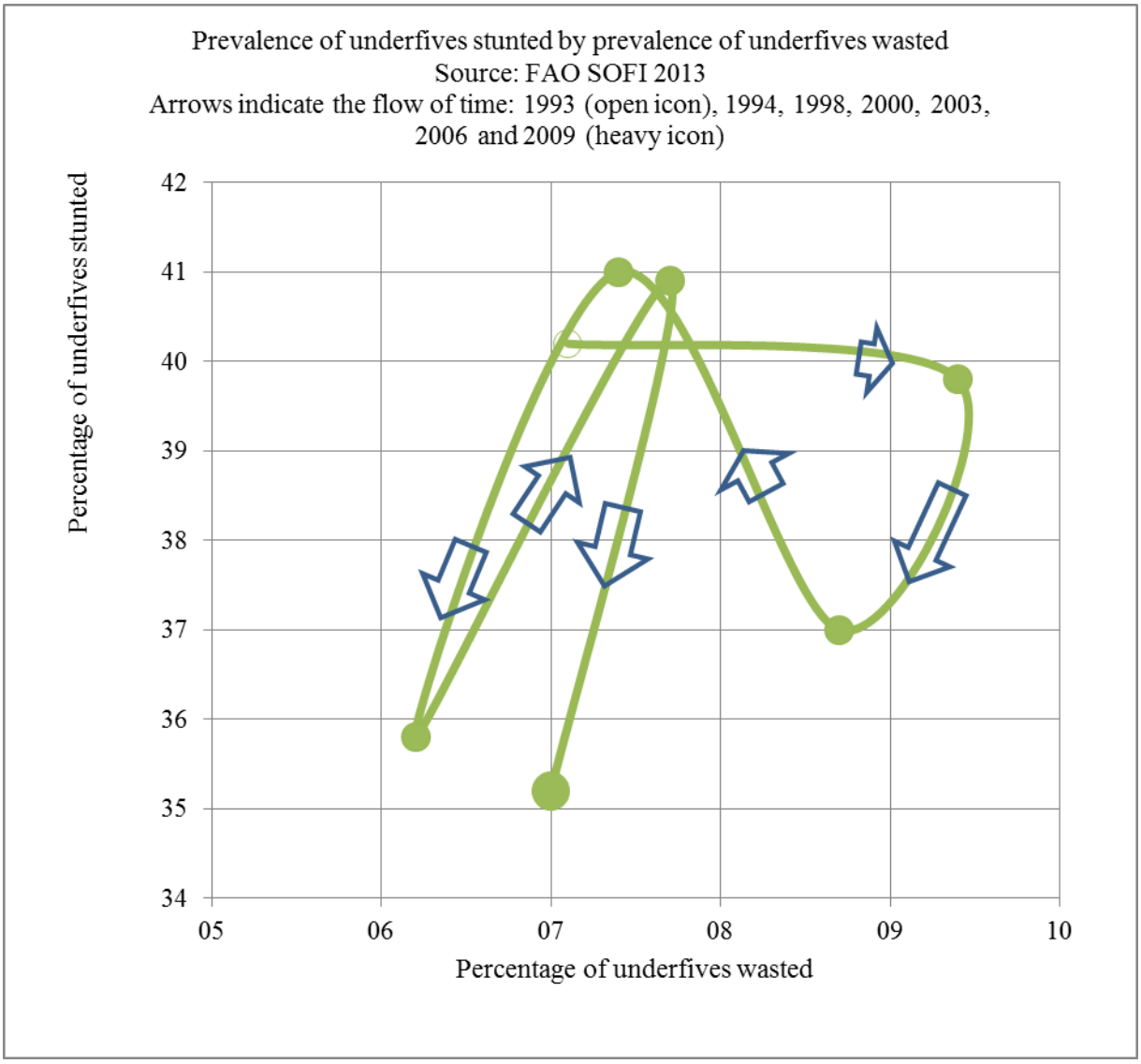
Figure 30b: Trends of hungry people and of under-nutrition among older under-fives in Kenya compared, 1990-2009



Sources:
Source of Prevalence of Undernourishment*:* FAO (2013), *State of Food insecurity in the World 2013*. Source of nutritional status data: 1993, 1998, 2003 and 2008/09 from DHS surveys, 2000 from Multiple Indicator Cluster Survey and 2006 from the Kenya Integrated Household Budget Survey(KIHBS). For lack of an algorithm by age group, the figures in this graph represent prevalences calculated with the old NCHS growth references.

Figure 32 shows that there are clear internal dynamics at play between the different dimensions of child under-nutrition: (i) from 1993 to 1994 more wasted children, (ii) from 1994 to 1998 improvement on both accounts, (iii) from 1998 to 2000 more stunting concomitant with less wasting, (iv) from 2000 to 2003 as (ii), (v) from 2003 to 2006 the reverse of (iv), and (vi) from 2006 to 2009 a redress. These internal dynamics may reflect an influence of seasonality, whereby seasonal changes in wasting and stunting are out of phase with each other. In a longitudinal study in the Kenya Coast during five seasons in 1985-86, height growth was at its maximum during the dry season, while maximum weight growth took place during the long rains (see Hoorweg *et al*., 1995: p. 88; Klaver & Mwadime, 2000: p. 288; Klaver & Nubé, 2008: p. 298).

Figure 32:



The areas of under-nutrition and severe under-nutrition also appear on Kenyan maps, as produced by the Centre for World Food Studies in Amsterdam (see Figures 33a/b and 34a/b). It is noteworthy that in absolute terms, the numbers of undernourished people are much higher in Kenya's areas with high population densities (around Nairobi and near Lake Victoria) than in Kenya's arid and semi-arid lands.

Figure 33a/b: Undernourished and severely undernourished areas in Kenya (around 2005)

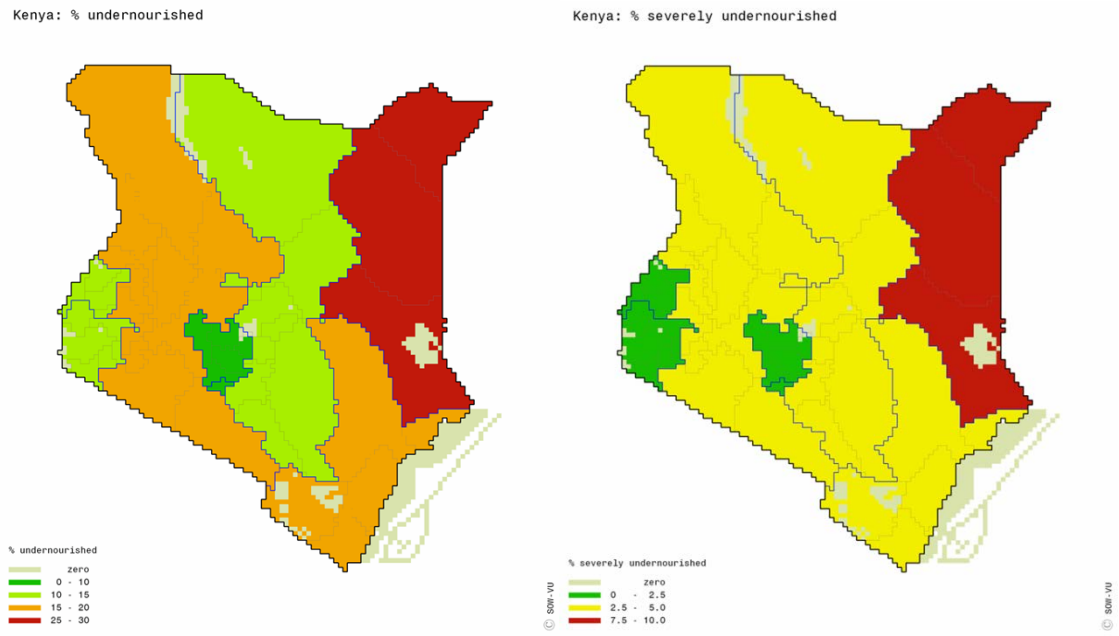
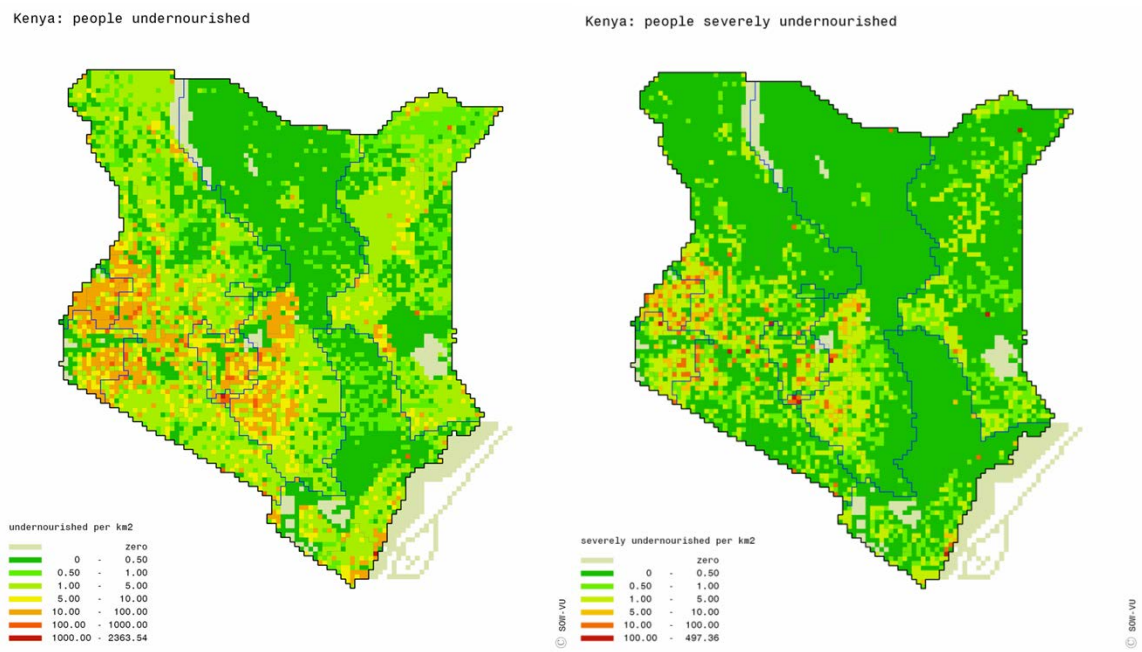


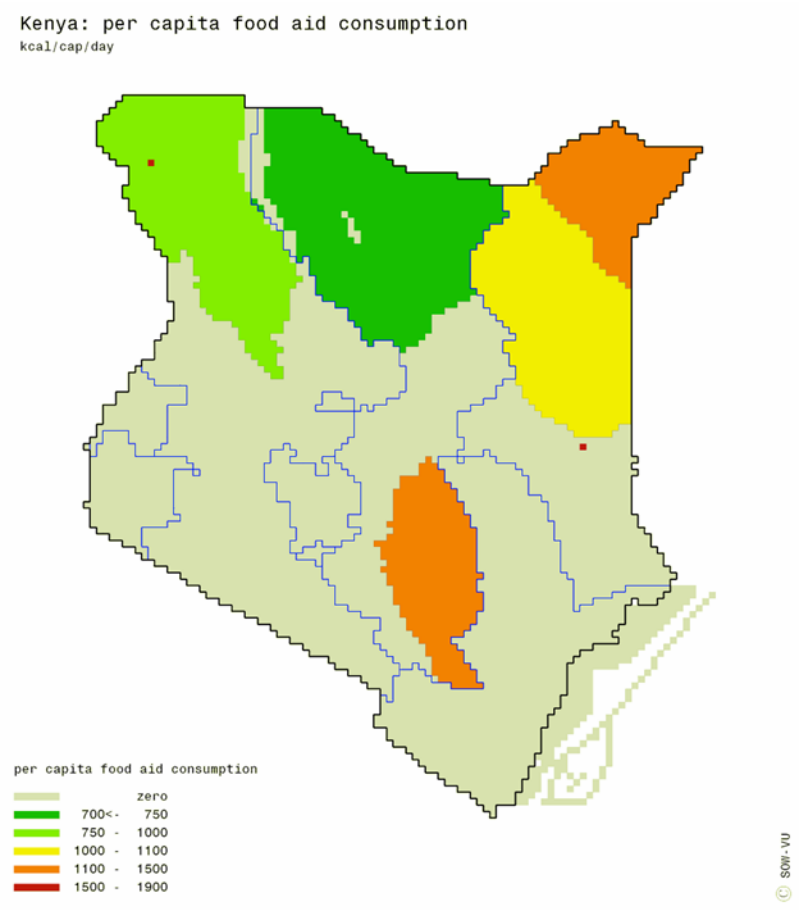
Figure 34a/b: Number of people undernourished and severely undernourished in Kenya



Source: Van Wesenbeeck, C.F.A. & M.D. Merbis (2012) Africa in Maps, data repository of the food economy in Sub-Saharan Africa. Amsterdam: Centre for World Food Studies

Food aid has become a standard element of food provisioning in some of these regions in Kenya, particularly in the northern Counties and in Kitui in Eastern Region. Figure 35 gives some details.

Figure 35: Food aid in Kenya: regional distribution of per capita food aid



Source: Van Wesenbeeck, C.F.A. & M.D. Merbis (2012) Africa in Maps, data repository of the food economy in Sub-Saharan Africa. Amsterdam: Centre for World Food Studies

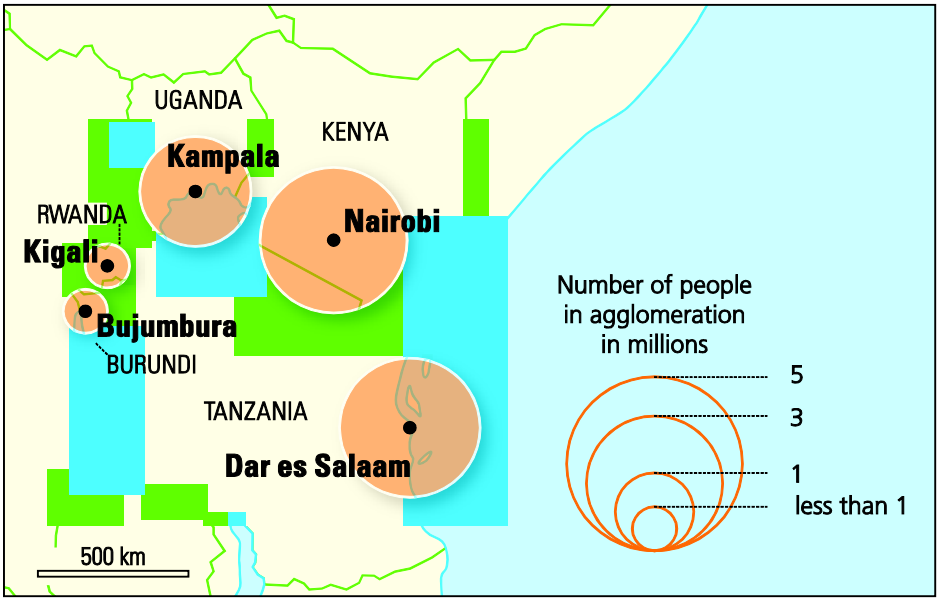
6 DRA/ASC-AFCA research questions for Kenya

In follow-up studies we would like to find out what made wheat, potatoes, bananas, beans, sweet potatoes, camels and cattle so successful during the last decade: market expansion, institutional arrangements (value-chain and agro-support institutions, including business development) and/or state support?

Market expansion mainly has to do with the expansion of the internal market in Kenya itself. According to FAOstat data very little food is exported (although there will be food [crop and livestock] trade across the borders, particularly with Somalia, Uganda, Ethiopia, South Sudan and Tanzania, and part of that might go unrecorded. And of course, Kenya has become well-known for successful horticultural exports, but as a percentage of food production this is very limited.

As everywhere else in Africa, Kenya's urban population is rapidly increasing. Its capital city, Nairobi, currently has close to 3.1 million people and the Nairobi agglomeration was estimated to be close to 3.5 million consumers[7] (see Figure 36). However, Kenya still has a relatively low urbanization rate: currently only 24% (see the Introduction to this Research Report). The last ten years, Kenya's economy is improving, and particularly its urban economy, although with ups and downs, and with major problems between 2007 and 2009 as a result of the post-election violence. Gradually, the urban consumers increase their demand on urban hinterlands and provide markets for agricultural production growth and innovation. It can also be expected that food insufficiency in nearby countries like South Sudan and Somalia increases demand for Kenya's agricultural produce.

Figure 36: Urbanization in Kenya and neighbouring countries



Source: ASC Thematic Map 2012.

We would also like to study the relevant institutional arrangements for agriculture in general (input support, quality assurance, education/training/extension including the role of the main Kenyan extension delivery service, credit, marketing support, logistical improvements, etc.) and for Kenya's most successful agricultural products a in particular. Government-based institutions are important in Kenya, but the private sector (Kenya-owned, but also some foreign influence) has become important as well.

[7] From ASC Thematic Map: 'Africa: from a continent of states to a continent of cities' (2012).

7 An inventory of relevant background information

A quick search of relevant sources in the academic and non-academic literature available in and around the African Studies Centre in Leiden and on the web gives us the following recent sources, which may be helpful for further preparations of the systematic comparative study that we envisage, as far as Kenya is concerned. The search has been limited to sources published between 1993 and 2013, and only if Kenya has been explicitly mentioned. We start with more general literature about what may be called 'agricultural dynamics', continue with literature about Kenya's food security and nutrition situation and end with specific attention for the three agricultural products that we would like to study: maize, rice and sheep. Where available as a free online source we also give the URL. The list also contains references used in this working paper.

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8 Useful links on food and nutrition security

http://www.ascleiden.nl/?q=research/projects/food-security-and-african-city-clustering-metropolitan-food-chains	ASC-AFCA Collaborative Research Group: Agro-Food Clusters in Africa (AFCA) This ASC collaborative project on Food security and the African city aims to explore and unpack dynamic urban food systems in Africa. The research outputs of this collaborative project are intended to, in part, serve as inputs for ongoing discussions between the Ministry of Foreign Affairs (MinBuza), the Ministry of Economic Affairs, Agriculture and Innovation (EL&I), the Netherlands African Business Council (NABC), Wageningen University (WUR), and the ASC, amongst others, about the establishment of 'Agro-Food Clusters' (AFC) in and around African cities.
http://www.ascleiden.nl/?q=research/projects/africa%E2%80%99s-food-and-nutrition-security-2010-2050	Africa's food and nutrition security: 2010-2050 This research programme will predict the food and nutritional needs of a number of African countries up to 2050 on the basis of: population size, growth rate and composition nutritional requirements by age and sex, and taking activity levels into account demands for various foods Intra-country and cross-country comparisons will be made regarding the choice of crops grown and the animals kept, and food consumption patterns (depending on dietary preferences, incomes and prices). Estimates will be made of the loss to human health and the economy. The projected demands of the future food basket on natural resources (land, water, fertilizer and energy) and the effects of emissions will also be assessed.
http://www.ascleiden.nl/?q=content/webdossiers/food-insecurity-famine-and-drought-africa	Food (in)security, famine and drought in Africa The African Studies Centre's library has compiled this web dossier to provide background information on the food (in)security situation in Africa. This coincides not only with the current food crisis in the Horn of Africa but also with the recent decision by the Dutch government to choose food security as one of the focal points of its economic and development cooperation policy.
http://www.ascleiden.nl/?q=content/asc-catalogue	ASC Catalogue This unique African studies database contains titles of monographs, journal articles and chapters from edited works. Most entries include professional in-depth abstracts. Access to the ASC catalogue is free of charge. Access is available via the Web.
http://www.pbl.nl/en/publications/2012/food-security-in-sub-saharan-africa-an-explorative-study	Food security in sub-Saharan Africa: An explorative study, Report | 02-07-2012 The agricultural production potential of sub-Saharan Africa would be sufficient to make the region food secure. Concerted and region-specific policies are needed to conserve and enhance the natural resource base of soil and nutrients, to make economic growth more beneficial for the poorest populations, and to eradicate the worst cases of malnutrition and food insecurity. In an exploratory study, PBL has analysed environmental and socio-economic trends and identified feasible policy directions at national and international levels.
http://www.sow.vu.nl/	Reporting and research of the world food situation Understanding and assessing the developments of the world food situation is a permanent and broad based activity of the Centre that

	covers, among others, the evolving status of malnutrition, agricultural and food policy, natural resource management. The world food situation often serves as motivation for fundamental issues in food and development policy, which are to be disseminated both to policy makers and the general public. With respect to the world food situation the Centre focuses on selected topics that need to be 53ember53ed more prominently. One example of recent research on food trends is the pressure that may arise in cereal markets due to the strong increase of meat consumption in fast growing developing countries.
http://apf-down2earth.ning.com/	Agriculture, Food Security and Climate Change How farmer entrepreneurs deal with the challenges
https://www.wageningenur.nl/en/Dossiers/file/Dossier-Food-security.htm	Dossier Food security. The world's population is increasing quickly, and it is predicted to grow to 9 billion people in 2050. In less than forty years the earth will gain 2 billion extra inhabitants who will also have to live, work and eat. Fortunately, our prosperity is also predicted to increase, which means that diets will be subject to change.
https://www.wageningenur.nl/en/show/Researchers-combine-food-security-knowledge.htm	Scientists investigating world food issues should unite themselves to provide a sound scientific basis for food security policies. "The way climate scientists have organised themselves in the IPCC, but then a lighter version." That idea arose during the First International Conference on Global Food Security 29 September – 2 October 2013 in Noordwijkerhout, The Netherlands, organised by Wageningen UR (University & Research centre) and publisher Elsevier. The scientific journal Global Food Security – published by co-organiser Elsevier – will also get a special issue with all results from the conference.
http://www.9billiontofeed.com/en/gafsr.htm	The Global Alliance on Food Security Research Six leading agri-food universities and research institutions (WUR, INRA, EMBRAPA, UC Davis, Massey Univ, IVF-CAAS) have joined forces to find ways to increase the world food production in a sustainable manner.
http://seasofchange.net/	Seas of Change: scaling inclusive agro-food markets "From Islands of Opportunity to Seas of Change" The coming decades require an unprecedented change in global agriculture and food systems to assure food security. Agriculture offers the best opportunity for the estimated 2 billion people living in smallholder households to work and trade their way out of poverty. Significant impact on poverty and food security requires change at scale, both scaling up successful approaches and implementing new approaches with scale built-in to the initial design.
http://www.foodsecure.eu/	FOODSECURE for Policies that Matter The EU FOODSECURE programme aims to design effective and sustainable strategies for assessing and addressing the challenges of food and nutrition security. FOODSECURE provides a set of analytical instruments to experiment, analyse, and coordinate the effects of short and long term policies related to achieving food security. FOODSECURE impact lies in the knowledge base to support EU policy makers and other stakeholders in the design of consistent, coherent, long-term policy strategies for improving food and nutrition security.

http://www.gainhealth.org	Global Alliance for Improved Nutrition (GAIN) GAIN's mission is to reduce malnutrition through sustainable strategies aimed at improving the health and nutrition of populations at risk
http://gainmap.gainhealth.org/admin/pdf/Africa.pdf	GAIN Regional Fact Sheet
http://www.gainhealth.org/partnerships/amsterdam-initiative-against-malnutrition-aim	The Amsterdam Initiative against Malnutrition (AIM), a Dutch partnership model that brings different stakeholders together to improve food and nutrition security. The partners in the initiative develop innovative market-based solutions to malnutrition in Africa and Asia. The partners in AIM all bring in their own expertise. AIM was launched in May 2009 during the GAIN Business Alliance Global Forum and its goal is to eliminate malnutrition for 100 million people in Africa by 2015. AIM represents an opportunity to combine the know-how of major players in the food and nutrition industry in seven countries: Kenya, Tanzania, South Africa, Ethiopia, Nigeria, Bangladesh, Indonesia. Dutch Diamond approach – Private, Public, Civil society, Academia multi-sector approach (Dutch Diamond approach – Private, Public, Civil society, Academia) to achieve sustainable nutritional results
http://www.gainhealth.org/programs/lessons-learned-food-fortification-africa	GAIN National Fortification Alliances: Experiences in food fortification from longstanding programs. Reaching 1.5 billion individuals with fortified foods. Experiences from longstanding programs in Nigeria, South Africa, Ghana, Cote d'Ivoire, Mali, Uganda, and Egypt can provide useful lessons for programs in earlier stages including those in Senegal, Mozambique, Kenya, and Tanzania.
https://www.securenutritionplatform.org/Pages/Home.aspx	Secure Nutrition, linking agriculture, food security, and nutrition The World Bank's SecureNutrition aims to bridge knowledge gaps between agriculture, food security, and nutrition. This platform offers a space to exchange experiences and to disseminate and gather information. Please join us in our quest to foster open development through increasing coordination and collaboration in the generation and sharing of knowledge.
http://www.ifpri.org	International Food Policy Research Institute: sustainable solutions for ending hunger and poverty. A 54ember of the CGIAR Consortium
http://www.ifpri.org/category/country/east-africa/kenya	IFPRI Publications and Programs: Kenya
http://cgmap.cgiar.org/start.iface?center=IFPRI	CGIAR Medium Term Research Plans
http://cgmap.cgiar.org/projectListView.iface	CGIAR Medium Term Research Plans
http://www.cgiar.org/	The Consultative Group on International Agricultural Research (CGIAR) is a global partnership that unites organizations engaged in research for a food secure future.
http://www.cgiar.org/resources/cgiarannual-reports/	CGIAR is a global partnership that unites organizations engaged in research for a food secure future.
http://library.cgiar.org/bitstream/handle/10947/2789/CGIAR_Annual_Report_2011.pdf?sequence=1	CGIAR research is dedicated to reducing rural poverty, increasing food security, improving human health and nutrition, and ensuring more sustainable management of natural resources. It is carried out by the 15 Centers that are members of the CGIAR Consortium, in

	close collaboration with hundreds of partner organizations, including national and regional research institutes, civil society organizations, academia and the private sector.
http://www.fao.org/publications/sofi/en/	The State of Food Insecurity in the World
http://www.fao.org/economic/ess/ess-fs/en/	Food security statistics (Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life).
http://www.fao.org/economic/ess/ess-fs/fbs/en/	Food balance sheets Food balance sheets provide essential information on a country's food system through three components: • Domestic food supply of the food commodities in terms of production, imports, and stock changes. • Domestic food utilization which includes feed, seed, processing, waste, export, and other uses. • Per capita values for the supply of all food commodities (in kilograms per person per year) and the calories, protein, and fat content.
http://faostat.fao.org/	FAOSTAT provides time-series and cross sectional data relating to food and agriculture for some 200 countries.
http://faostat.fao.org/site/291/default.aspx	FAOSTAT "Classic"
http://faostat3.fao.org/faostat-gateway/go/to/home/E	New FAOSTAT (Pilot Version)
http://www.fao.org/economic/ess/ess-capacity/countrystathome/en/	The national version of FAOSTAT, CountrySTAT, is being developed and implemented in a number of target countries, primarily in sub-saharan Africa. It will offer a two-way data exchange facility between countries and FAO as well as a facility to store data at the national and sub-national levels.
http://www.fao.org/fsnforum/	The Global Forum on Food Security and Nutrition. The FSN Forum is a worldwide community of experts and practitioners on Food Security and Nutrition issues and organizes online discussions to exchange knowledge and to inform the global dialogue and decision-making processes. With over 4500 Members from 170 countries and territories, the FSN Forum allows stakeholders such as academics, researchers, development practitioners, governments and the civil society to actively participate in the debate on topics of the global Food Security and Nutrition agenda and to provide constructive feedback along several policy formulation processes.
http://www.cabi.org/	CABI is an inter-governmental, not-for-profit organization that was set up by a United Nations treaty. CABI's mission is to improve people's lives worldwide by providing information and applying scientific expertise to solve problems in agriculture and the environment.
http://www.fara-africa.org/	The Forum for Agricultural Research in Africa (FARA) is an apex organization bringing together and forming coalitions of major stakeholders in agricultural research and development in Africa. It is a strategic platform that fosters continental and global networking to reinforce the capacities of Africa's agricultural science and innovation community from research, education/training, extension and civil society engaged in agriculture.
http://www.asareca.org/	The Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) is a sub-regional not-for-profit

	association. It was established in 1994 by ten member countries represented by their national agricultural research for development institutes. The 10 member countries are: Burundi, Democratic Republic of Congo, Eritrea, Ethiopia, Kenya, Madagascar, Rwanda, Sudan, Tanzania, and Uganda. South Sudan joined ASARECA in 2011.
http://www.nepad-caadp.net/	CAADP stands for "Comprehensive Africa Agriculture Development Programme". CAADP is the agricultural programme of the New Partnership for Africa's Development (NEPAD), which in turn is a programme of the African Union (AU). The CAADP pillars are CAADP's four key focus areas for agricultural improvement and investment. They are 'Sustainable Land and Water Management'; 'Market Access'; 'Food Supply and Hunger'; and 'Agricultural Research'.
http://www.kari.org/	The Kenya Agricultural Research Institute (KARI) is a semi-autonomous government institution bringing together research programmes in food crops, horticultural and industrial crops, livestock and range management, land and water management, and socio-economics. KARI promotes sound agricultural research, technology generation and dissemination to ensure food security through improved productivity and environmental conservation.
http://www.kippra.org/Collaborative-Research/monitoring-african-food-and-agricultural-policies.html	The Monitoring of African Food and Agricultural Policies (MAFAP) project is a joint undertaking between the Kenyan Institute for Public Policy Research and Analysis (KIPPRA), the Food and Agriculture Organization (FAO) and the Kenya Agricultural Research Institute (KARI). The project intends to help policy-makers and other stakeholders ensure that policies and investments are supportive of agricultural development, the sustainable use of natural resources and enhanced food security. The project aims to support decision-making at national, regional and Pan-African levels, thereby contributing to the Comprehensive Africa Agriculture Development Programme (CAADP) of the New Partnership for Africa Development (NEPAD) [see above]
http://www.potatoplatformkenya.com/index.htm	Potato platform Kenya – The Netherlands. Collaborative platform in the field of potato production and marketing.
http://www.codesria.org/	The Council for the Development of Social Science Research in Africa (CODESRIA) is headquartered in Dakar, Senegal. It was established in 1973 as an independent pan-African research organization primarily focusing on social sciences research in Africa.
http://www.oecd.org/countries/kenya/	The Organization for Economic Co-operation and Development (OECD) provides a forum in which governments can work together to share experiences and seek solutions to common problems. OECD works with governments to understand what drives economic, social and environmental change. It measures productivity and global flows of trade and investment, and analyses and compares data to predict future trends. It sets international standards on a wide range of things, from agriculture and tax to the safety of chemicals.

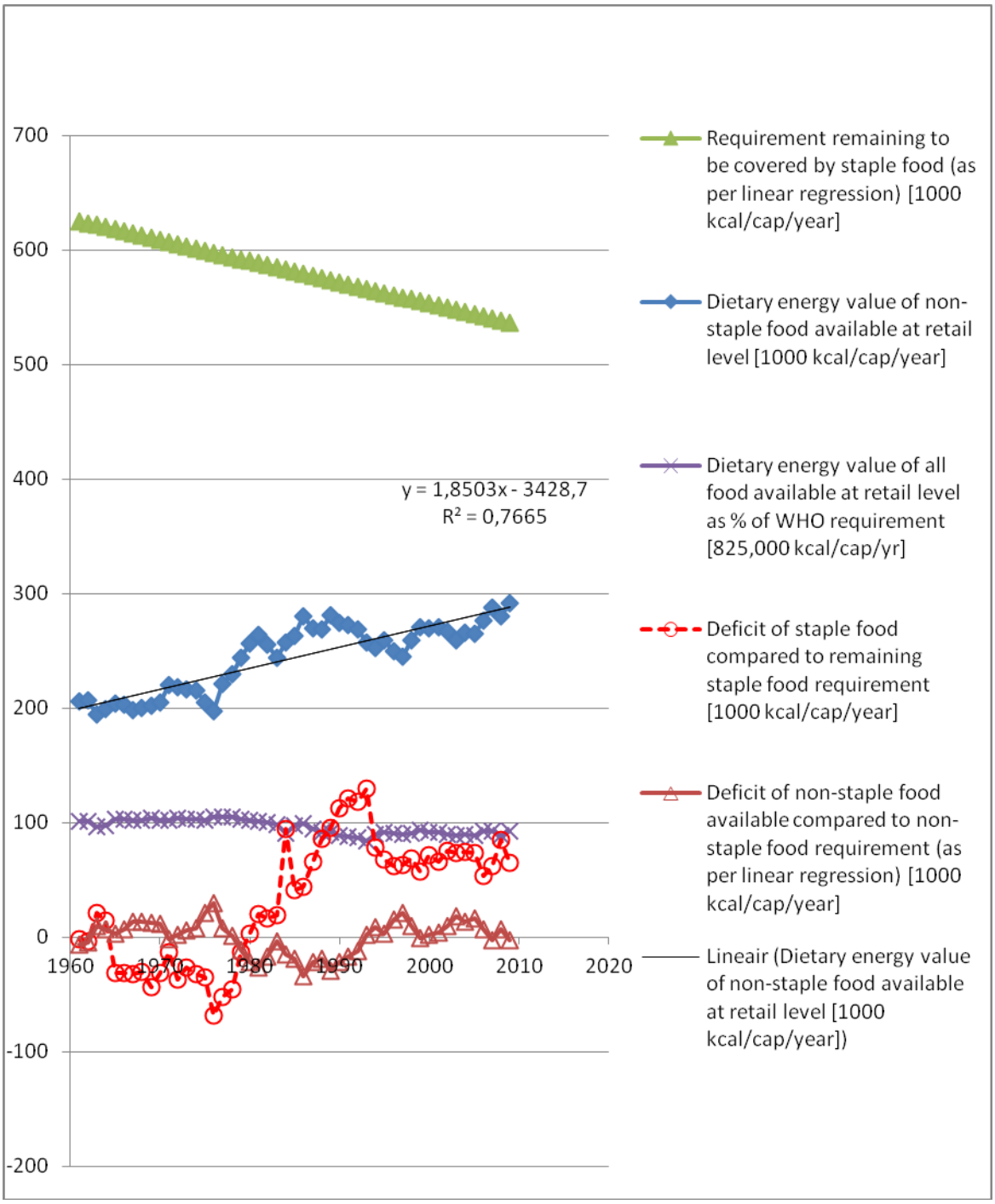
Annex

In section 1 agricultural production data have been used for staple food development, to determine the level of food security that could be reached if all available production would be used for national consumption (without exports, imports, stock changes and waste). Staple foods are the most important elements of diets, but of course people also consume non-staple foods, and the percentage of diets consisting of non-staple foods differs per country and through time. To get a realistic idea about 'potential food security based on national production' it is useful to determine the staple food/non-staple food percentages. In this annex, first a simple method and calculation will be presented, followed by a more complex one.

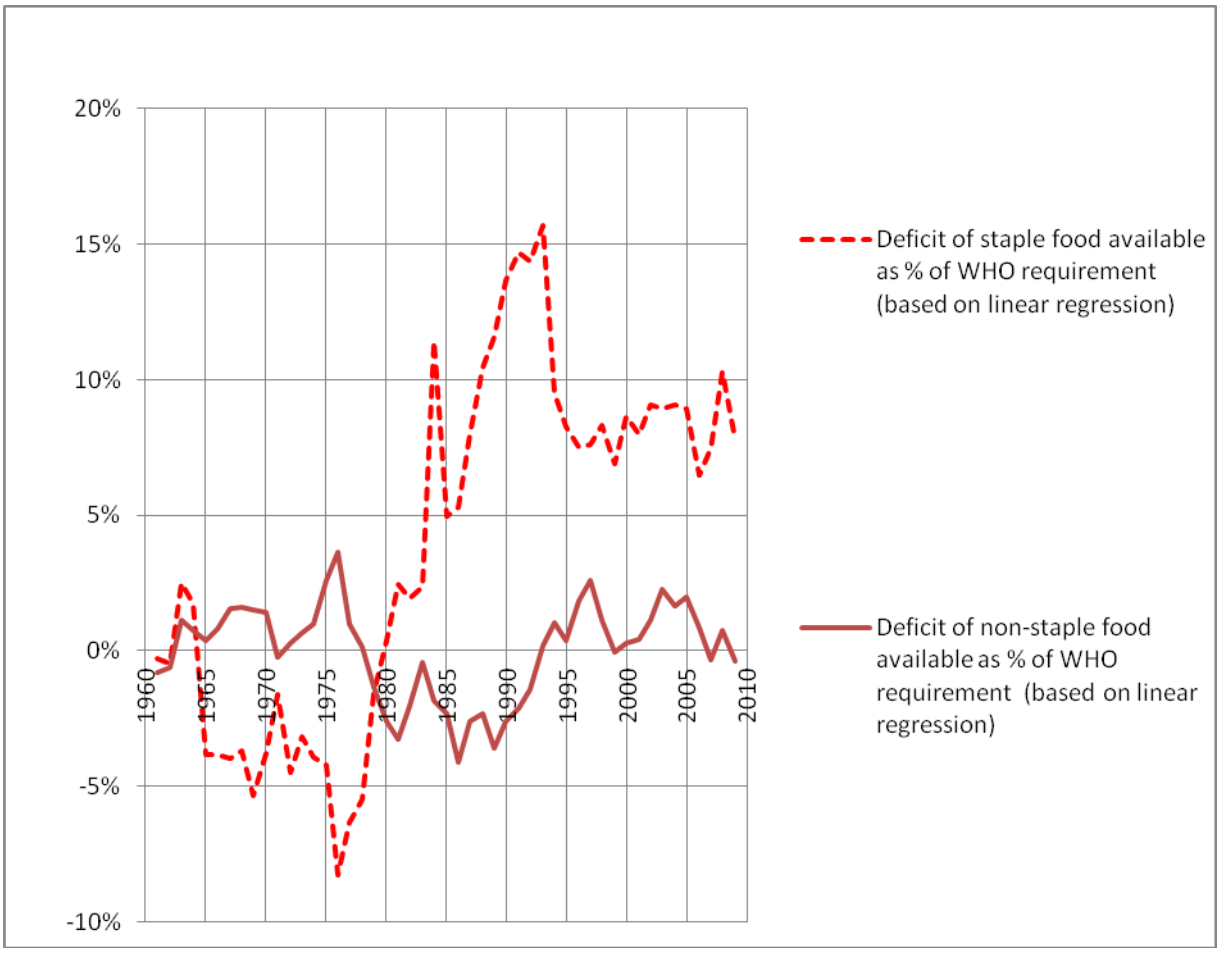
First a linear regression was run on existing statistics. Lineair regression analyses shows that non-staple foods added 200,000 kcal/cap/yr 1961, 272,000 kca,/cap/yr in 2000 and 289,000 kcal/cap/yr in 2010. There has been an increase in dietary diversity, potentially diminishing the relative importance of staple foods. If we would take 825,000 kcal/cap/yr as the WHO-recommended requirement for a healthy life, it would mean that staple foods should have contributed 625,000 kcal/cap/yr in 1961 (76%), 553,000 kcal/cap/yr in 2000 (67%) and 535,000 kcal/cap/yr in 2009 (65%). See graphs KE-A1 and KE-A2.

Not satisfied with the assumption that non-staple food availability does *not* suffer from systematic deficits over time, a new regression is proposed based on the ratio of staple to non-staple food. The time trend shows three distinct periods as presented in Graph KE-A3.

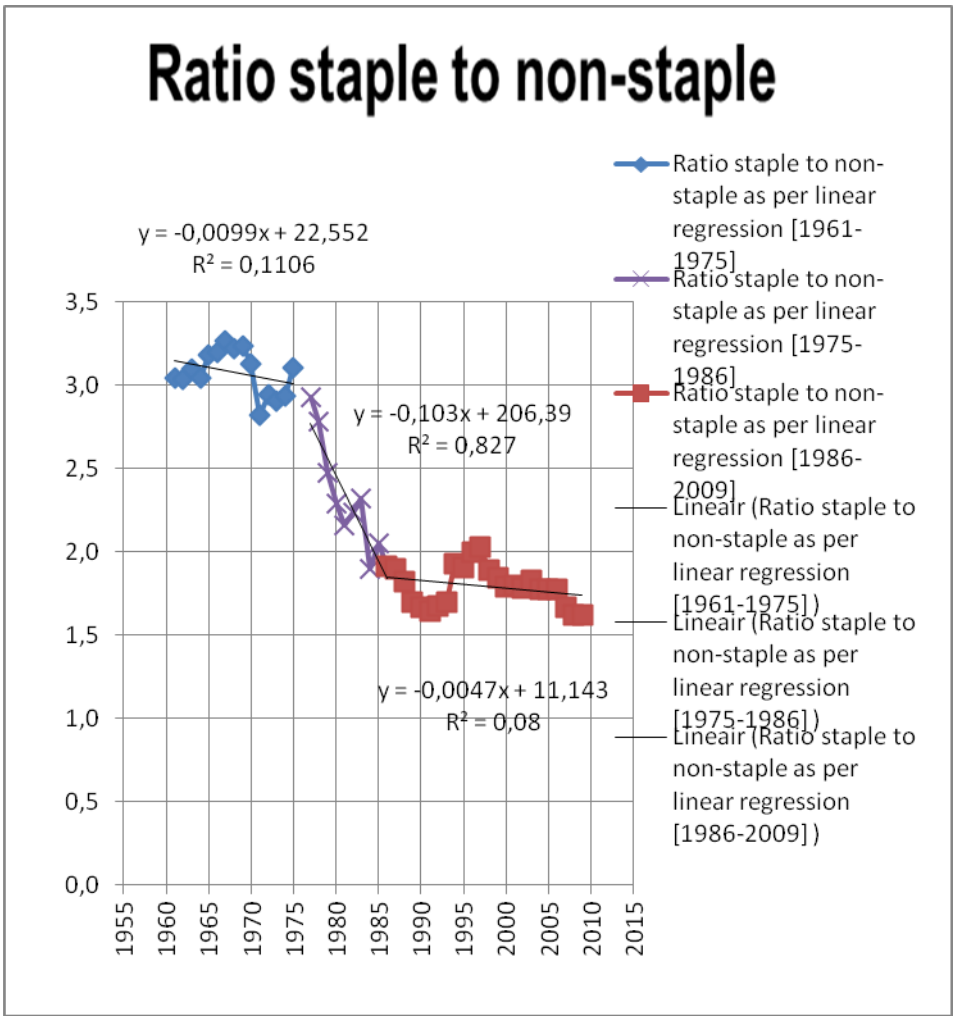
Graph KE-A1: Requirements, availability and deficits of staple and non-staple foods, Kenya 1961-2009



Graph KE-A2: Deficits of staple and non-staple foods, Kenya 1961-2009 (as a percentage of WHO requirements, assuming zero trend for non-staples)



Graph KE-A3: Regression of ratio of staple to non-staple energy over time, in three periods [improved scenario]

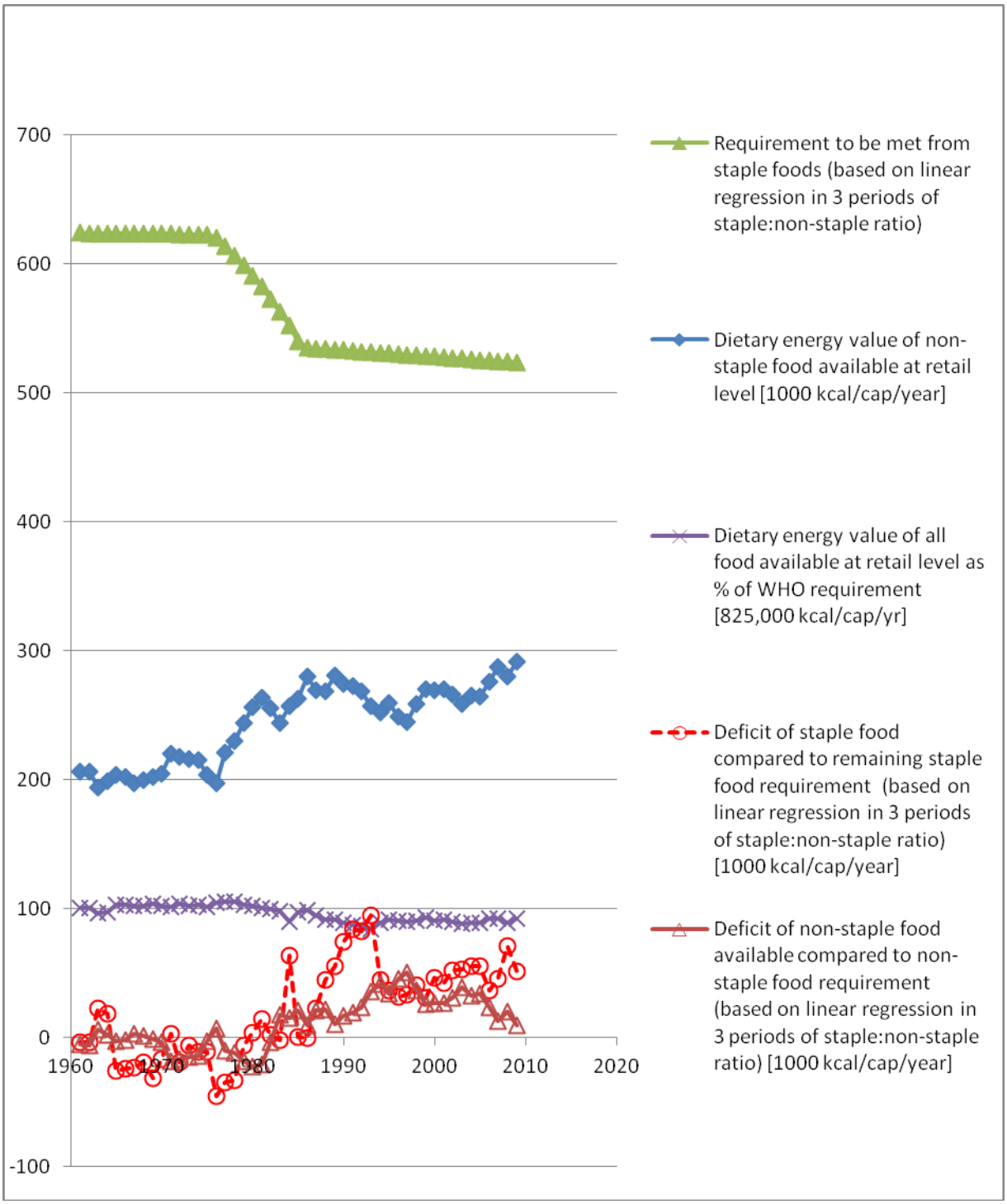


Note: If r is the ratio between staple and non-staple energy, the percentage of staple food energy out of total food energy is calculated as: r/(1+r).

- From 1961-1975 a ratio of around 3:1 (corresponding to 75% from staple foods)
- Between 1975 and 1986 a rapid dietary transition from a ratio 3 to a ratio of 1.9 (corresponding to 65% from staple foods)
- From 1986 to 2009 a plateauing at a ratio of 1.9 to 1.7 (i.e. 65-64% from staple foods)

As can be seen in the following graphs (KE-A4 and KE-A5), from the mid-1980s onwards both staple foods and non-staple foods fail to keep up with population growth. In the last decade, staple food deficit is 6% of total WHO requirements (i.e. 51,000 kcal per person per year or 140 per day), with a peak of 8% in 2008 (assuming that around 65% of requirements are to be covered by staple foods) and the non-staple food deficit is 3% (i.e. 26,000 kcal per person per year or 70 per day) assuming that about 35% of requirements are to be covered by non-staple foods).

Graph KE-A4: Requirements, availability and deficits of staple and non-staple foods, Kenya 1961-2009 (before, during and after the dietary transition between 1975 and 1986)



Graph KE-A5: Deficits of staple and non-staple foods, Kenya 1961-2009 (before, during and after the dietary transition between 1975 and 1986) (as a percentage of WHO requirements)

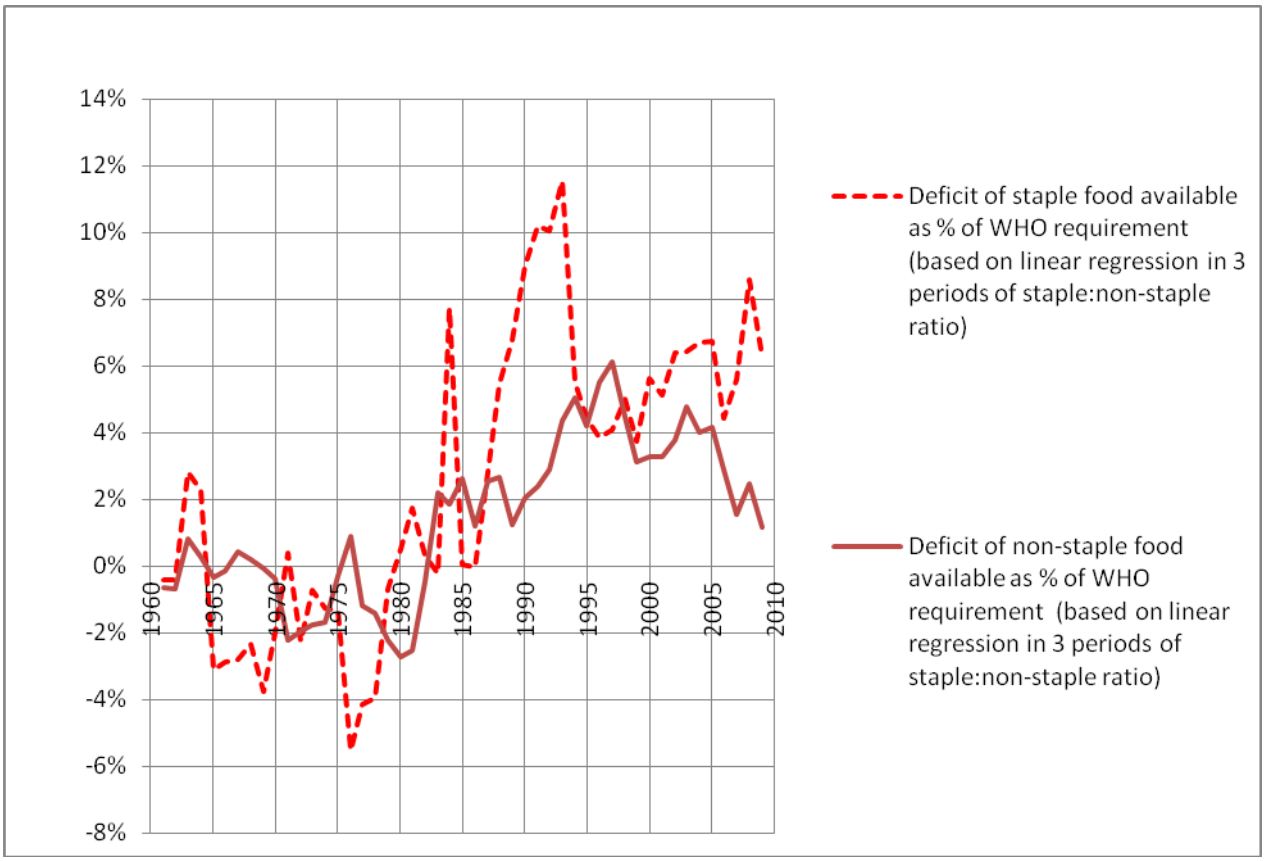


Table A1: Details of staple food/non staple food production in energy terms in Kenya in 1961 and 2000-2009, and production-based food deficits

	1961	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total deficit [1000 kcal/cap/year]	*-9*	*73*	*69*	*84*	*92*	*88*	*90*	*60*	*59*	*91*	*61*
Total all available foods	*834*	*752*	*756*	*741*	*733*	*737*	*735*	*765*	*766*	*734*	*764*
Total staple crops	*627*	*482*	*485*	*475*	*474*	*471*	*470*	*489*	*479*	*453*	*472*
Dietary energy value of non-staple food available at retail level [1000 kcal/cap/year]	206	270	270	266	259	266	265	276	288	280	292
Ratio staple to non-staple	3.0	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6	1.6
Percentage staple	75.3%	64.1%	64.3%	64.0%	64.7%	63.9%	64.0%	63.9%	62.5%	61.8%	61.8%
Ratio staple to non-staple as per linear regression [1961-1975]	3.11										
Ratio staple to non-staple as per linear regression [1975-1986]											
Ratio staple to non-staple as per linear regression [1986-2009]		1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.7	1.7
Percentage staples in total diet [as per linear regression over 3 periods]	75.7%	64.0%	64.0%	63.9%	63.8%	63.8%	63.7%	63.7%	63.6%	63.5%	63.5%
Requirement to be met from staple foods (based on linear regression in 3 periods of staple:non-staple ratio)	624	528	528	527	527	526	526	525	525	524	524
Requirements to be met from non-staple foods (based on linear regression in 3 periods of staple:non-staple ratio)	201	297	297	298	298	299	299	300	300	301	301

Table A1 ctd	1961	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Deficit of non-staple food available compared to non-staple food requirement (based on linear regression in 3 periods of staple:non-staple ratio) [1000 kcal/cap/year]	*-5*	*27*	*27*	*31*	*39*	*33*	*34*	*24*	*13*	*20*	*10*
Deficit of staple food compared to remaining staple food requirement (based on linear regression in 3 periods of staple:non-staple ratio) [1000 kcal/cap/year]	*-3*	*46*	*42*	*53*	*53*	*55*	*56*	*36*	*46*	*71*	*52*
Deficit of non-staple food available as % of WHO requirement (based on linear regression in 3 periods of staple:non-staple ratio)	*-0.7%*	*3.3%*	*3.3%*	*3.8%*	*4.8%*	*4.0%*	*4.2%*	*2.9%*	*1.5%*	*2.5%*	*1.2%*
Deficit of staple food available as % of WHO requirement (based on linear regression in 3 periods of staple:non-staple ratio)	*-0.4%*	*5.6%*	*5.1%*	*6.4%*	*6.4%*	*6.7%*	*6.7%*	*4.4%*	*5.6%*	*8.6%*	*6.3%*

Any enquiries, suggestions, criticisms: dietzaj@ascleiden.nl. Your assistance is welcome!

African Studies Centre, Leiden; December 2013